

# Innovative Stormwater Treatment Technologies



## Best Management Practices Manual



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# **Innovative Stormwater Treatment Technologies Best Management Practices Manual**

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## Disclaimer

The technology descriptions contained in this document including, but not limited to, information on technology applications, performance, limitations, benefits, and cost, have been provided by vendors. No attempt was made to examine, screen or verify company or technology information. The New Hampshire Department of Environmental Services has not confirmed the accuracy or legal adequacy of any disclosures, product performance, or other information provided by the companies. The inclusion of specific products in this document does not constitute or imply their endorsement or recommendation by the New Hampshire Department of Environmental Services.

# Introduction

Urban stormwater carries a number of pathogens, nutrients, heavy metals, sediment, and other contaminants as surface runoff flows over land. The increase in impervious or paved surfaces associated with development in urban areas reduces the natural infiltration of precipitation into the ground. With impervious cover, precipitation collects and carries contaminants before draining into nearby surface waters. Stormwater runoff from paved surfaces in developed areas can degrade downstream waters with both contaminants and increased volumes of water.

This publication aims to make information on innovative stormwater treatment technologies more available to New Hampshire's urban planners, developers, and communities. Traditional runoff management techniques such as detention basins and infiltration swales may be preferable, but are not always practical for treating urban stormwater. Lack of space for natural solutions is often a problem in existing developed areas, making innovative treatment technologies an attractive alternative. Mostly designed for subsurface installation, urban "retrofits" use less space than conventional methods to treat stormwater. This manual provides information on the innovative stormwater "retrofit" technologies currently available for use in developed areas in New Hampshire.

## Purpose of Manual

The Innovative Stormwater Treatment Technologies Best Management Practices Manual has been developed in response to a New Hampshire Estuaries Project (NHEP) Water Quality Action Plan. The purpose of this manual is to provide innovative stormwater treatment technology information for developed areas within New Hampshire. In addition to providing detailed product information including function, installation, operation and maintenance, and relative cost, this manual also offers decision-making criteria to help in determining the most efficient Best Management Practice (BMP) system for specific site conditions.

The technologies in this manual are primarily for use in already-developed urban areas where traditional stormwater treatments cannot be used due to space constraints. Areas of new development and existing development that are not restricted by space should use traditional and low impact development (LID) practices. These LID techniques reduce the development impact left in the natural landscape, and reduce the future need for stormwater retrofits. For more information on low impact development, please refer to the Low Impact Development References in the appendix.

## How to Use this Manual

This manual is divided into five chapters:

### Chapter 1. Understanding Urban Stormwater

This chapter gives an overview of general stormwater information to answer the questions: What is stormwater? Why is it a problem? and, why is there a need for innovative stormwater treatment technologies? In addition, this chapter outlines the common pollutants in stormwater, examples of pollutant sources, and their related impacts.

## **Chapter 2. Selecting the Right Stormwater BMP Technology**

This chapter describes considerations for choosing a BMP system. A list of decision criteria and questions aimed at obtaining answers to narrow the list of BMP technologies, and select the most appropriate BMP system for specific site conditions is provided.

## **Chapter 3. Cold Climate Considerations**

This chapter lists and explains cold climate consideration that should be addressed prior to BMP selection and installation. In addition, this chapter discusses the potential for additional, more frequent maintenance requirements during late fall and winter months in New Hampshire due to seasonal occurrences such as leaf fall, and road salting and sanding.

## **Chapter 4. Installation, Operation and Maintenance Planning**

This chapter emphasizes the importance of creating installation and operation & maintenance plans to increase the efficiency and longevity of BMPs. This section includes a template for site information, and an operation and maintenance schedule logbook page.

## **Chapter 5. Best Management Practices**

This chapter gives details on several innovative stormwater BMPs and includes a technology summary matrix. The matrix is designed to allow the reader to easily view the characteristics of each BMP and refer to the assigned page in the manual for greater detail of those technologies that appear most appropriate for a specific project. For each new technology, this section provides information on the BMP general description, target contaminants, applications, installation and maintenance considerations, relative cost, performance, existing installations located in New Hampshire or New England, and installation and manufacturer contact information.

# Chapter 1

## Understanding Stormwater Pollution

This chapter provides an overview of general stormwater information to answer the questions: What is stormwater? Why is it a problem? And, why is there a need for innovative stormwater treatment technologies? In addition, this chapter outlines the common pollutants in stormwater, examples of pollutant sources, and their related impacts.

### 1.1. What is Urban Stormwater?

Urban stormwater occurs when precipitation falls onto impervious surfaces (such as parking lots and roads) and flows over the ground surface rather than infiltrating through the soil. Without infiltration, water flows over land and collects sediment and other non-point source pollutants that lie in its path. In urban (or developed) environments, stormwater contaminants originate from different land use types and activities occurring within the watershed. These can include fertilizing lawns and oil or gas spills at automobile service stations.

Urban stormwater becomes a problem when pollutants such as pesticides, fertilizers, animal wastes, sediments, nutrients, and heavy metals, deposited on the ground surface, flow into and contaminate nearby surface waters. The increasing amount of impervious cover, particularly in developing and developed urban areas, reduces the ability of stormwater to be treated through natural processes such as ground infiltration. Implementing innovative stormwater technologies to treat and control stormwater is one way to reduce pollutant concentrations before being discharged into sensitive surface waters, groundwater, and wetlands.

### 1.2. Common Stormwater Pollutants

Contaminants that are typically found in stormwater are associated with land use activities in urban or developed areas. Table 1.1 summarizes the pollutants commonly found in stormwater, explains their sources, and gives examples of their potential related impacts.

Table 1.1. Common stormwater pollutants, sources, and possible impacts.

<b>Stormwater Pollutant</b>	<b>Examples of Sources</b>	<b>Possible Impacts</b>
<b>Nutrients:</b> Nitrogen, Phosphorus	Animal waste, fertilizers, failing septic systems, atmospheric deposition, vehicular deposition	Algal growth, reduced clarity, other problems associated with eutrophication (oxygen deficits, release of nutrients and metals from sediments)
<b>Sediments:</b> Suspended in water column and deposited on bottom of water body	Construction sites, other disturbed and/or non-vegetated lands, eroding banks, road sand	Increased turbidity, reduced clarity, lower dissolved oxygen, deposition of sediments, smothering of aquatic habitats including spawning sites
<b>Organic Materials</b>	Leaves, grass clippings	Oxygen deficit in receiving waters, fish kills, turbidity
<b>Pathogens:</b> Bacteria and Viruses	Animal waste, failing septic systems, dumpsters	Human health risks associated with drinking water supply, consumption of affected shellfish and swimming beach contamination
<b>Hydrocarbons:</b> Oil and Grease, PAHs such as Napthalenes & Pyrenes	Industrial processes, automobile wear, emissions and fluid leaks, waste oil	Toxicity of water column and sediment, bioaccumulation through the food chain
<b>Metals:</b> Lead, Copper, Cadmium, Zinc, Mercury, Chromium, Aluminum, others	Industrial processes, normal wear of auto brake linings and tires, automobile emissions and fluid leaks, metal roofs	Toxicity of water column and sediment, bioaccumulation in aquatic species and through the food chain, fish kills
<b>Synthetic Chemicals:</b> PCBs, Pesticides	Pesticides (herbicides, insecticides, fungicides, rodenticides), industrial processes	Toxicity of water column and sediment, bioaccumulation through the food chain, fish kills.
<b>Chlorides</b>	Road salting and uncovered salt storage	Toxicity of water column and sediment
<b>Trash and Debris</b>	Litter washed through storm drain networks, commercial parking lots adjacent to surface water, overflowing trash barrels and dumpsters	Degradation of surface water aesthetics, threat to wildlife

(Adapted from Minnesota Urban Small Sites BMP Manual).

Note: See glossary for unfamiliar terms.

# Chapter 2

## Selecting the Right Stormwater BMP Technology

This chapter describes considerations for choosing a BMP system. A list of decision criteria and questions aimed at obtaining answers to help narrow down the BMP options, and select the most appropriate BMP system for site specific conditions is provided.

### 2.1. Decision Criteria

To achieve the greatest effectiveness of a BMP system, it is necessary to determine the type(s) of BMPs that are most suitable for the characteristics of a project site. The following is a list of questions and considerations that should be addressed in order to determine which BMP or combination of BMPs is/are most suitable for a specific site.

#### Site Considerations

##### *What are the target pollutants for treatment?*

The type of land use and activities within a drainage area determine the types of contaminants that may be present in stormwater. Land use types can be classified as: rural, residential, roads and highways, agriculture, commercial, industrial and ultra-urban sites. Different types of BMP technologies treat different contaminants. Because of this, it is important to know the types of contaminants present in stormwater runoff in order to choose the most appropriate BMP for treatment of site specific target contaminants.

##### *What are the potential site limitations for installation and operation?*

#### Protected, restricted or sensitive areas

Protected, restricted or sensitive areas are located adjacent to a waterbody, close to the groundwater table, a habitat for a threatened species, or for various other reasons. Sites in proximity to protected, restricted or sensitive areas require careful consideration, and may require special permits as well as additional time and equipment for proper erosion, sediment, and disturbance control. If you are unsure whether or not a proposed area is protected, restricted, or sensitive, contact the local town offices, the New Hampshire Natural Heritage Inventory (271-3623), or NH DES (271-3505).

#### Drainage area

The size of the drainage area, the amount and type of land use activity, the amount and frequency of rainfall and flow within the area, and the slope are important factors in BMP selection. Many BMPs are designed to treat a maximum flow of water (measured in cubic feet per second (cfs)). Knowing the average flow in cfs and the size of the drainage area will help determine the type(s), number, and configuration of BMPs needed for a specific site.

#### Proximity to the water table

The depth to the water table is a consideration in terms of ease and expense of installation, as well as precautionary measures that may be required to protect against groundwater contamination. Many BMPs,

especially those that use filtering as the primary treatment method, require installation at a specific depth above the water table in order to function properly and allow for drainage.

It is important to have proper equipment on-site for activities such as pumping excess water from the excavation area and defining an appropriate receiving area for that excess water.

### Depth to bedrock

The depth to bedrock or other impermeable layer is a consideration in terms of ease and expense of BMP installation. Bedrock is the solid layer of parent material below the soil. Installation of a subsurface, or below-ground BMP at a depth below the bedrock surface, increases labor and equipment needed for excavation, because blasting and other special equipment is often necessary.

## Installation Considerations

### *What is the land area available for installation?*

Because most innovative stormwater BMPs are installed in areas with limited space, it is important to know the amount of land available for excavation and installation. Typically, BMP size increases as the drainage area and amount of water treated increases. The installation site should be sized accordingly.

### *How much time, labor, and equipment are required for installation, and what is the associated cost?*

Knowing the time, labor, and equipment required for installation are important factors for ensuring an efficient, safe, and organized installation, as well as an affordable one. The time required for installation should be a factor in determining installation cost, because a greater number of laborers and amount of time will result in a greater overall cost. Rental or purchase of special equipment necessary for installation such as cranes, backhoes, and pumps should also be a cost consideration.

### *Is pretreatment necessary?*

Pretreatment is the process of treating stormwater runoff before it reaches the primary BMP. Pretreatment typically includes such practices as settling basins, infiltration trenches, constructed wetlands, treatment swales, and even other innovative BMPs, which are installed to reduce the amount of contaminants and/or to slow the flow of water prior to primary treatment. The majority of BMPs described in this manual do not require pretreatment and can be used as stand alone treatment devices. However, when pretreatment is necessary, it typically increases the overall project costs.

## Maintenance Considerations

### *How often should the BMP be inspected?*

It is important to know the schedule and routine of inspection necessary to ensure proper BMP functioning. Typically, the manufacturer is able to recommend an inspection schedule in order to establish an appropriate maintenance schedule. The manufacturer should also be able to provide the required inspection guidelines.

*What are the short- and long-term maintenance costs and requirements?  
Can these requirements be met and who is responsible for ensuring they are met?*

BMP inspection and maintenance must be considered in the selection process. If maintenance requirements are not met after installation, the BMP will not operate properly and will not produce effective treatment of stormwater runoff. Because of this, before selecting a BMP, it is important to know the equipment necessary for maintenance. Many BMPs require the use of a vacuum truck or other heavy machinery for removal of collected debris. If such equipment is not already available, its purchase is a considerable added cost that must be factored into the total project cost.

It is recommended that all BMP installation projects have structured maintenance plans prior to installation as part of the initial project proposal. For further details of installation, operation and maintenance planning, see Chapter 4.

### Aesthetics and Community

*Does the BMP blend into the landscape?*

Careful planning, landscaping, and upkeep are important in maintaining visual aesthetics of a BMP. If the installation site is in an area of public gathering, a subsurface installation may be more appealing.

*Does the community support the installation and understand the concept and function of the BMP?*

Public availability of BMP educational materials and activities is often helpful for acceptance and understanding of a BMP's function. Activities to increase public understanding and awareness include press releases that describe the project and its need, educational signs and postings at the project site, or a BMP "open house" to invite the community to view the BMP and provide a discussion forum.

*Are there safety concerns involved with a particular BMP?*

For BMP installations in areas frequented by community members, particularly children, such as parks, schools, or other recreation areas, BMPs should be selected with safety concerns in mind. For areas where there is potential for the BMP to be disturbed or vandalized, consideration should be given to selecting a BMP that is less obvious and less likely damaged.

### Cost

*Is the BMP installation, operation, and maintenance affordable?*

It is important to select the most effective BMP system for a specific site for the most reasonable cost, and to take long-term maintenance and replacement costs into consideration. A BMP is only effective if it is properly maintained. In addition to the benefits that can be quantified in dollars, it is also important to consider the benefit of improved water quality.

## Verification Ranking

### *What types of studies have been performed to test the product efficiency?*

The extent of product claim verification and product efficiency verification are determined by the studies that have been conducted on a particular BMP product. A product that has been repeatedly tested and successful in removing contaminants could be more confidently selected as a BMP option than one that has not. However, an individual product should not necessarily be excluded from selection if it has not undergone critical testing. Several products are new to the market and have not yet undergone, or are currently in the process of testing.

Chapter 5 includes information on the type of performance data available for each technology, including a list of the studies conducted on each product. NH DES has developed a ranking system to help the reader determine the extent of data currently available. This ranking system is based on who was responsible for conducting the study and the types of studies conducted, including laboratory or field studies, or an accepted literature review of product claims. This ranking system does not attempt to verify the method or the results of each study.

The five-point system is based on the assumption that manufacturer-conducted testing has a greater potential for bias than an accepted literature review (such as the Massachusetts Strategic Envirotechnology Partnership (STEP) Program) or a third party-conducted study, and is, therefore, a less desirable type of study for product verification. Laboratory studies tend to have more control over the results, but may not be representative of “real-life” conditions, whereas field studies tend to have “real-life” conditions, but are subject to unplanned events and other types of variability. For technologies that have had a combination of testing types, the BMP will be assigned the highest rank.

The ranking criteria is as follows:

**0** - no study conducted or no current information available

◆ - manufacturer-conducted, laboratory study

◆◆ - manufacturer-conducted, field study

◆◆◆ - third party-conducted, laboratory study

◆◆◆◆ - third party-conducted, field study

◆◆◆◆◆ - accepted literature review of product claim

### NH Installations

*Have there been previous installations in New Hampshire or in the Northeast? If yes,*

*What are the results/successes of existing New Hampshire installations?*

Knowledge of previously installed BMPs in NH provides first hand information regarding installation, success of operation, relative cost and areas of concern. Each technology description in Chapter 5 includes a New Hampshire installation contact section, which provides the contact information of a person responsible for a BMP. For those technologies not yet installed in New Hampshire, contact information is provided for the nearest installation, where available.



# Chapter 3

## Cold Climate Considerations

This chapter lists and explains cold climate considerations that should be addressed prior to BMP selection and installation. This chapter also discusses the potential for additional maintenance requirements during late fall and winter months in New Hampshire due to seasonal occurrences such as leaf fall, road salting and sanding, freezing, and vegetative die-off.

### 3.1. Concerns

Many innovative technologies have been designed and installed in other warmer regions of the country. Items to be considered when selecting a BMP to be installed in New Hampshire are as follows:

- **Frost heaves** – potential to damage structural features of BMP such as pipes or concrete infrastructure
- **Pipe freezing** - when freezing occurs there is a reduction in treatment as well as risk of flooding
- **Reduced biological activity** - for BMPs that rely on biological mechanisms to reduce nutrients and organic matter. Cold temperatures reduce microbial activity
- **Reduced settling velocities** - when water cools, its viscosity increases, which reduces particle velocity by up to 50% and makes it more difficult for particles to settle out
- **Reduced infiltration** - due to freezing of soils and filter media
- **Increased runoff volumes during snowmelt** - if the ground remains frozen, snowmelt cannot infiltrate the soil and instead will contribute to the amount of runoff present
- **Access difficulties in ice and snow** - access points frozen shut, difficulty locating BMPs under snow load

### 3.2. Maintenance Requirements

Maintenance requirements of certain BMPs may increase during winter months due to increased loading and debris. Pollutant loading typically increases due to leaf fall, plowing, sanding, salting, and accumulation of materials in snow piles. Cold climate pollutants include:

- Sand
- Salt
- PAHs - Polycyclic Aromatic Hydrocarbons emitted from fireplaces and inefficient vehicles in winter
- Cyanide - salt additive to prevent clumping

BMPs that use filtration, settling, or trapping to remove contaminants require frequent inspection and maintenance. Regular maintenance of BMPs is suggested just prior to the first snowfall or road sanding, after the last snowfall, and during spring snowmelt to ensure proper treatment of runoff.



# Chapter 4

## Installation, Operation and Maintenance Planning

This chapter emphasizes the importance of creating installation, and operation and maintenance plans to increase the efficiency and longevity of BMPs. This section gives a template for site information and an operation and maintenance schedule logbook page.

### 4.1. Installation

Before installation begins, an installation plan should be created to include such details as:

- Person(s) responsible for installation
- Engineering design
- Cost of installation
- Equipment required
- Precautionary plans (for encountering water, bedrock, etc.)
- Schedule
- Permit applications
- Persons to be contacted:
  - Well in advance of installation
    - DIGSAFE
    - Utility companies
    - Permitting agencies
    - Local DPW
    - Property owner
    - Manufacturer
  - Day of installation
    - Police/Fire
    - Utility companies
    - Abutters/Nearby Business

### 4.2. Operation and Maintenance

Before installation, an operation and maintenance logbook should be created with a BMP maintenance schedule and procedure to include such details as:

- BMP owner(s) and contact information
- Person(s) responsible for operation/maintenance
- Definition of maintenance tasks and required equipment
- Schedule of maintenance tasks
- Cost of maintenance & source(s) of continued funding
- Manufacturer maintenance contract, if applicable
- Health and safety plan for maintenance personnel
- Persons to be contacted:
  - In case of question or emergency
  - For routine record keeping, or transmittal of maintenance log

Documented details of project information, inspection, and maintenance routines are an important part of ensuring extended BMP efficiency. Accurate project records are helpful in case of property ownership changes, or operation or maintenance issues. Log templates for product specific BMPs are typically available from the manufacturer. An example of a project information and maintenance log sheet is given below in Table 4.1.

Table 4.1. Example of site and contact information, and inspection/maintenance log.

Product Reference Number:				
Site Name:				
Site Location:				
Installation Date:				
Owner:		Contractor:		
Contact Name:		Contact Name:		
Company Name:		Company Name:		
Telephone:		Telephone:		
Fax:		Fax:		
Address:		Address:		
Specifications/ Maintenance Instructions:				
Maintenance Log				
Date	Initials/ Organization	Inspection Observations	Maintenance Activity Performed	Comments
				...
Notes:				

### 4.3. Operation Monitoring

It is often desirable to monitor the operation of an installed BMP. Monitoring will ensure that maintenance is being performed correctly, that the installed BMP is operating as intended (according to any manufacturer warranty and protective of downstream water quality), and that the body of literature on BMPs continues to grow. Local conservation commissions, volunteer watershed groups, performance verification programs, such as the EPA's Environmental Technology Verification (ETV) Program (<http://www.epa.gov/etv>), or NH DES staff may be available to assist with the development of a monitoring plan.



## Chapter 5

### Best Management Practices

This chapter gives details on several innovative stormwater BMPs. For each technology, this section provides information on BMP general description, target contaminants, applications, installation and maintenance considerations, relative cost, performance, existing installations located in New Hampshire, and manufacturer contact information. The information in this chapter should be used in conjunction with professional site assessment and engineering plans and should not be a substitute for professional consultation.

Table 5.1. Technology description summaries including target contaminants, cost range, NH Installation, ranking and page number.

	Technology	Target Contaminants	Cost Range	NH Installation (Y/N)	Verification Ranking	Page
<b>Swirl Separators</b>	BaySaver	<ul style="list-style-type: none"> <li>suspended sediment</li> <li>free oils</li> <li>floating debris</li> </ul>	\$3,000 - \$8,000/acre drainage area	Yes	●●	5-1
	CDS Unit	<ul style="list-style-type: none"> <li>trash &amp; debris</li> <li>vegetative material</li> <li>coarse sediment</li> </ul>	\$15,700 - \$61,800/unit	Yes	●●●	5-4
	Downstream Defender	<ul style="list-style-type: none"> <li>settleable solids</li> <li>floatables, oil &amp; grease</li> </ul>	\$10,200 - \$29,600/unit	Yes	●●●●	5-8
	Stormceptor	<ul style="list-style-type: none"> <li>oil &amp; grease</li> <li>sediment</li> </ul>	\$7,600 - \$33,560/unit	Yes	●●●●●	5-11
	Vortechs	<ul style="list-style-type: none"> <li>sand, settleable debris</li> <li>hydrocarbon-laden sediment</li> <li>petroleum-based liquids</li> <li>floatables</li> </ul>	\$8,900 - \$40,000/ unit	Yes	●●●●●	5-13
	HYDRASEP	<ul style="list-style-type: none"> <li>oil &amp; grease</li> </ul>	\$9,000/unit	No	●●●	5-16
	AquaSwirl	<ul style="list-style-type: none"> <li>sediment</li> <li>oil &amp; grease</li> </ul>	\$7,500 - \$28,000/unit	No	0	5-19
<b>Retrofit Constructed Wetland Device</b>	StormTreat	<ul style="list-style-type: none"> <li>solids, metals</li> <li>oil &amp; grease</li> <li>phosphorus</li> <li>bacteria</li> </ul>	\$7,500 - \$15,000/acre impervious drainage area	Yes	●●●●●	5-23
<b>Filtration Systems</b>	AquaFilter	<ul style="list-style-type: none"> <li>sediment, debris &amp; oil</li> <li>hydrocarbons</li> <li>phosphorus &amp; nitrogen</li> <li>VOCs, PCBs, metals</li> </ul>	\$25,000 - \$69,000/unit + replacement filter bags	No	●●●●	5-26
	StormFilter	<ul style="list-style-type: none"> <li>TSS</li> <li>soluble metals</li> <li>soluble phosphorus, nitrates</li> <li>oil &amp; grease</li> </ul>	\$15,000 - \$30,000+ /unit	No	●●●●	5-29

Table 5.1. (continued). Technology description summaries including target contaminants, cost range, NH Installation, ranking and page number.

	Technology	Target Contaminants	Cost Range	NH Installation (Y/N)	Verification Ranking	Page
<b>Patented Vegetated Swale</b>	Howland Swale	<ul style="list-style-type: none"> <li>flow control</li> <li>silts</li> </ul>	\$400 - \$600/ installation	No	●●	5-32
<b>Catch Basin Systems</b>	Ultra-Urban Filter	<ul style="list-style-type: none"> <li>oil &amp; grease</li> <li>trash</li> <li>sediment</li> </ul>	\$250 - \$590/unit + various part costs	No	●●●●	5-35
	StreamGuard	<ul style="list-style-type: none"> <li>oil</li> <li>sediment</li> <li>trash &amp; debris</li> </ul>	\$64.00 - \$93.00/unit + \$560 - \$820/unit for inserts	Yes	●●●●	5-38
	AquaGuard	<ul style="list-style-type: none"> <li>coarse sediment</li> <li>trash/debris</li> <li>dissolved oil</li> <li>nutrients</li> <li>metals</li> </ul>	\$1,500 - \$3,500/unit	No	0	5-42
	DrainPac	<ul style="list-style-type: none"> <li>debris</li> <li>solids</li> </ul>	No standard size, priced filter medium	No	0	5-45
	Fossil Filter	<ul style="list-style-type: none"> <li>sediment</li> <li>trash/debris</li> <li>hydrocarbons</li> <li>heavy metals bound to sediment</li> </ul>	Avg. \$500/unit, \$40.00 for replacement filter medium	Yes	●●●●	5-48
	Grate Inlet Skimmer Box	<ul style="list-style-type: none"> <li>sediment</li> <li>trash/debris</li> <li>hydrocarbons</li> </ul>	\$695 - \$995/unit	No	●●●●	5-51
	Hydro-Kleen	<ul style="list-style-type: none"> <li>hydrocarbons</li> <li>sediment</li> <li>organically-bound metals</li> <li>PCBs pesticides</li> <li>VOCs, sulfides</li> </ul>	\$2,000/unit +\$400 for replacement filter media	No	●●●	5-54
	Inceptor	<ul style="list-style-type: none"> <li>oils &amp; grease</li> </ul>	\$625 - \$1,100/unit + filter pillow replacement (\$69 -\$89/unit)	No	●●●●	5-57
<b>High Efficiency Sweepers</b>	Schwarze Sweeper	<ul style="list-style-type: none"> <li>debris down to 2.5-micron</li> </ul>	\$185,000 - \$225,000/unit	No	●●●●	5-59
	TYMCO sweeper	<ul style="list-style-type: none"> <li>trash</li> <li>debris</li> </ul>	\$60,000 - \$175,000	Yes	●●●●	5-62

0 - no study conducted or no current information available      ●●● - third party-conducted, laboratory study  
 ● - manufacturer-conducted, laboratory study      ●●●● - third party-conducted, field study  
 ●● - manufacturer-conducted, field study      ●●●●● - accepted review of product claim

## 5.1. Swirl Separators

### 5.1.1. BaySaver

#### General Description

The BaySaver system is comprised of two precast concrete manholes and a high-density polyethylene (HDPE) separator unit. It relies on gravity sedimentation and flotation to remove and retain the collected contaminants. The BaySaver works as the dual settling chambers and internal flow splitter act in tandem to provide different levels of treatment for different runoff intensities. Coarse sediments are removed in the first structure, and the finer sediments and floating pollutants are removed and trapped in the second during periods of low flow that comprise most storm events. During more intense storms, the elbow pipes draw water from below the surface in the first manhole. This water is free of floatable pollutants, and suspended sediments have had time to settle out. At moderate flow rates, the elbow pipes draw water from the center of the first manhole and discharge it directly downstream. The concrete manholes are cast to the applicable specifications by local precasters.



#### Site Considerations

The BaySaver Separation System is a water quality unit that targets and removes suspended sediments, free oils, floating debris, and other pollutants from stormwater runoff. The BaySaver System can be used to improve the quality of stormwater runoff from high traffic areas, to contain potential spills, as a pretreatment step in a longer treatment process, and for numerous other applications. Specific potential uses include:

- High traffic parking lots
- Gas and service stations
- Spill control for potential hotspots
- Industrial maintenance facilities
- Highway stormwater runoff
- Pretreatment practices to increase longevity of already installed traditional or innovative BMPs

The BaySaver units come in three standard sizes depending on the treatment flow and drainage area able to be treated by each unit. Table 5.2 below summarizes the unit sizes and treatment capacities.

Table 5.2. Unit size and treatment capacities for BaySaver systems..

Separator Unit	Unit Diameter	Manhole Size	Treatment Flow	Bypass Flow	Treatable Drainage Area
1K	24"	48"	2.4 cfs	8.8 cfs	1.2 – 1.6 acres
3K	36"	60"	7.2 cfs	24 cfs	1.6 – 4.4 acres
5K	48"	72"	11 cfs	39 cfs	4.4 – 8.0 acres

The BaySaver separator unit includes an internal bypass that discharges high flow rates directly downstream without treatment during intense flows to avoid flooding.

### Installation

The BaySaver systems are most easily installed at the same time as the storm drain, but can be retrofitted for existing pipes. The manholes are standard structures, and the BaySaver is joined to each structure using standard storm drain connections. No pretreatment is required for the BaySaver system.

### Maintenance

The BaySaver must be periodically maintained. Maintenance is conducted with a vacuum truck, and consists of removing the accumulated pollutants. Both inspection and maintenance can be done above ground, without confined space entry. Maintenance requires only partial removal of the stored water thus reducing disposal costs. The manufacturer states that the BaySaver will continue to treat stormwater runoff as long as it is adequately maintained.

### Aesthetics, Community and Safety

Concerns regarding aesthetics, community support, and safety are highly site specific. For further information refer to Chapter 2, Decision Criteria.

### Cost

Material and installation cost estimates for the different systems are shown below in Table 5.3. Treatment costs range from \$3000 to \$8000 per acre, depending on the system size and contributing drainage area.

Table 5.3. Material and installation cost estimates for BaySaver systems.

	1K System	3K System	5K System
Separator Unit	\$3990	\$5990	\$7990
Primary Manhole (estimated)	\$900	\$1900	\$2600
Storage Manhole (estimated)	\$1000	\$2000	\$2700
Installation Cost (estimated)	\$3000	\$4000	\$5000
Total System Cost	\$8890	\$13,890	\$18,290

### Performance and Verification Ranking

Verification Ranking: 

Several studies are currently underway for the BaySaver System. Previous studies have shown TSS removal efficiencies of between 78%-88%. Please contact the manufacturer for updates.

Studies:

- *Recap of TSS Removal Tests Performed by the University of Maryland and by BaySaver, Inc.* Hillis Carnes Engineering Associates. BaySaver, Inc. August 1997.

### Installation Contact

Location: Hooksett Sunoco Station  
1248 Hooksett Rd. US Rt. 3  
Hooksett, NH  
Date Installed: Fall 2001  
Contact: Sean McDonald  
Northeast Earth Mechanics, Inc.  
175 Barnstead Road  
Pittsfield, NH 03263  
Tel: (603) 435-7989  
Email: seanm@neearth.com

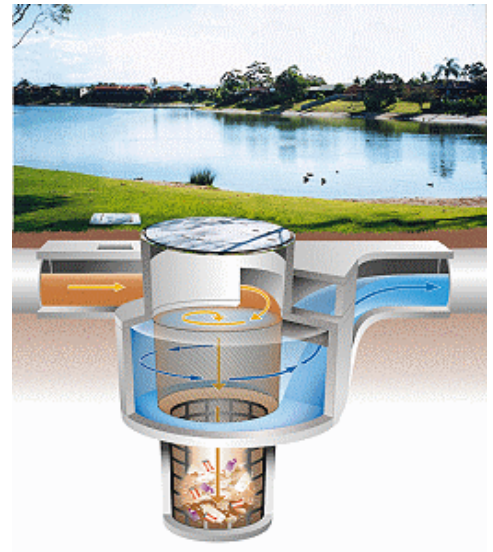
### Manufacturer

Company: BaySaver, Inc  
Address: 1010 Deer Hollow Drive  
Mount Airy, MD 21771  
Telephone: (301) 829-6407 or (800)-BAYSAVE  
Fax: (301) 829-3747  
Website: [www.baysaver.com](http://www.baysaver.com)  
Contact: Mark Hausner

## 5.1.2. Continuous Deflective Separation (CDS) Unit

### General Description

The Continuous Deflective Separation (CDS) technology uses fluid dynamics to effect a separation of solids from liquids. CDS offers precast standard size units or cast-in-place units specifically designed for individual site conditions. The unit is designed to set up a continual flow of liquid that passes over the face of the screen in a hydraulically balanced separation chamber. Solids are captured and retained within the central chamber and the fluid passes through the screen and exits via the outlet pipe. Solid pollutants are retained in a centrally located solids catchment chamber with the heavier solids ultimately settling into the base of the unit or sump.



### Site Considerations

The CDS unit is designed for the removal of gross stormwater pollutants. It targets and removes trash, debris, vegetative material and coarse sediments prior to discharge to receiving waters and wetlands. Applications include parking lot runoff treatment to control trash and debris and low levels of oil and grease when absorbents are added to the separation chamber. CDS can provide protection of stormwater pumping facilities and work well for redevelopment and retrofit for ultra-urban applications. Specific potential uses include:

- Commercial service and parking areas
- Industrial areas
- Public property and parkland
- Residential streets and private property

The recommended design flows for the CDS units are typically those with a return frequency of 3 to 6 months. These flows are normally in excess of those required to generate movement of pollution typically associated with “first flush” events. However, should higher flows be identified as movers of pollution in a particular watershed, CDS capacity should be treated accordingly. CDS units are capable of treating flows ranging from 0.7 cfs to 300 cfs.

### Installation

CDS Units are compact and installed below ground. In general, a CDS unit occupies about 4 ½ square feet of plan view area for each cfs that it treats, with the bulk of the plan view area being well below grade. CDS personnel will be onsite during installation to assist the owner or contractor. Pretreatment is not required for CDS Unit operation. The CDS Unit can be used as a pretreatment for other traditional or innovative BMPs. Specific installation details can be obtained through manufacturer contact.

### Maintenance

The maintenance requirements and cost of the CDS unit in stormwater applications is highly site specific depending on the level of development within and characteristics of the watershed and the generation of floatable trash and debris and settleable material.

Preventative maintenance cleanout schedules can be developed based on periodic inspections and experience with the operation of the CDS unit. The units typically require cleanout of accumulated material four times annually when the technology serves a developed urbanized area. The cleanout of the sump is a critical component of a successful operation and performance of the CDS unit because the sump is the depository for all captured settleable pollutants. The standard models are provided with a standard size cleanout sump that can be cleaned by methods determined by the client. The method for cleanout is generally client-specific depending on the equipment available for the sump cleanout and size of the unit.

CDS Technologies recommends that a clamshell bucket be utilized for CDS Models CSW150 (15' in diameter) and larger, and that vacuum truck systems, baskets or small clam bucket be utilized for cleaning smaller units. The smaller CDS units should be dewatered prior to cleaning when using vacuum techniques. These methods have been found to be most cost-effective; however, vacuum removal can be relatively slow due to blockages in the suction hose when the sump contains a high content of sticks and branches.

CDS Technologies recommends the following maintenance procedures for stormwater applications:

- **New Installations:** Check the condition of the unit after every runoff event for the first 30 days. This should include a visual inspection to ascertain that the unit is functioning properly and measuring the amount of deposition that has occurred in the sump and depth of floatable material. This can be performed using a “dip stick” that is calibrated so the depth of the deposition can be tracked.
- **Ongoing Operation:** During the wet weather season, the unit should be inspected at least once every 30 days. The floatables should be removed and the sump cleaned when the sump is above 85% full. At least once a year, the unit should be pumped down and the screen should be carefully inspected for damages and to ensure that the screen is properly fastened. Power washing of the screen is recommended prior to inspection.

Maintenance requires vehicle access for the removal of trash and debris and sediment. CDS will provide maintenance service of the units through contracts and support the initial year of maintenance inspections.

### Aesthetics, Community and Safety

Concerns regarding aesthetics, community support, and safety are highly site specific. For further information refer to Chapter 2, Decision Criteria.

### Cost

The cost of precast CDS units range from \$15,700 for a 3 cfs unit to \$61,800 for the 26 cfs unit delivered to the job site. The equipment costs of the precast units per cfs treated ranges from \$2,377 to \$5,233. Installation costs are site-specific depending on the need to relocate utilities, working space and depth of installation, but are typically approximately ½ to 1 times the unit cost.

Cleanout costs are user-specific and vary according to the amount and types of debris, floatables, and sediment captured by the CDS unit, safety requirements for the area of operation, equipment utilized, disposal costs and personnel costs.

Units installed to date are being cleaned using a vactor system being operated by the system operator. Table 5.4 shows the average costs of collection baskets and vacuum removal for maintenance based on the unit model.

Table 5.4. CDS average costs of collection baskets and vacuum removal based on model.

CDS Model	Collection Basket	Vacuum Removal
P30 (3' diameter)	\$500	\$400
P70 (7' diameter)	\$750	\$525
P100 (10' diameter)	\$900	\$675
P150 (15' diameter)	\$1200 – 1450 using clam shell technique	

### Performance and Verification Ranking

Verification Ranking: ●●●

Studies:

- *Continuous Deflection Separation (CDS) Unit for Sediment Control in Brevard County, Florida.* Brevard County Surface Water Improvements. July 1997.

Trash and Debris:

The design features of the CDS unit, and previous installations confirm that the system captures and retains 100% of the trash, debris and particulates in stormwater larger than the minimum screen aperture size (0.048 – 0.185 inches), as well as a very high percentage (>90%) of material down to 1/3 of the screen aperture.

Total Suspended Solids:

Independent laboratory tests on prototype units conducted by the Department of Civil Engineering at Monash University in Australia indicate that the CDS unit traps virtually 100% of the particulate material  $\frac{1}{2}$  the aperture size and >90% of the particulates  $\frac{1}{3}$  of the aperture size. A 2400-micron (0.096-inch) screen achieved 95% removal of particles of 800 micron (coarse sand) and 50% removal of particles of 475 micron (medium sand).

The cleanout of a CDS unit found that approximately 26% of the material removed is gross liter, 39% vegetative matter and 35% inorganic matter. Over half of the sediment collected was less than 200 microns (medium sand) and 11% less than 50 micron (silt). These removals are in part attributed to finer material attached to larger particles and higher removal efficiencies that occur during lower flows.

Oil and Grease:

The CDS units are not specifically designed nor have been extensively tested for removal of oil and grease; however, oil and grease attached to floating debris (Styrofoam, etc) and attached to sediments will be captured and retained. The design features of the separation chamber will retain floating oil and provides an area where sorbent material can be applied and dispersed to achieve maximum contact with floating and emulsified oil and grease.

CDS Technologies has contracted for additional research and development work by the Commonwealth Scientific, Industrial and Research Organization (CSIRO) and the Department of Civil Engineering, Monash University in addition to its own research and development facilities. The USEPA Wet Weather Research Program is conducting a test of the CDS CSO application as part of the studies at Rockland County, New

York. Effectiveness of the CDS system to remove sediments and oil and grease using absorbent material in the separation chamber is being evaluated at UCLA and the fin particle separation capability of the CDS unit is being evaluated at Portland State University.

### Installation Contact

Location: The Sewerage Works Improvements-Temple Street Area  
Nashua, NH  
Date Installed: January 2002  
Contact: Alan LeBlanc PE, Design Engineer  
Camp Dresser & McKee, Inc.  
1001 Elm Street, 2<sup>nd</sup> Floor  
Manchester, NH 03101-1845  
Tel: (603) 222-8380

### Additional Installations Include:

Crystal River, FL  
Santa Monica, CA  
Australia  
New Zealand

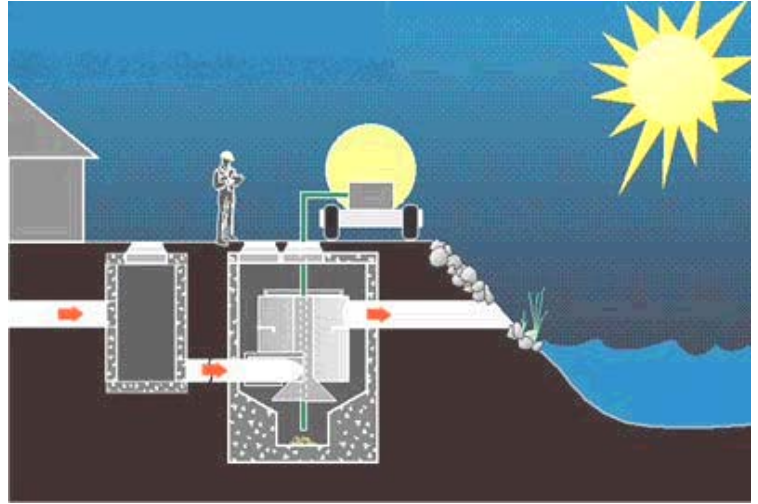
### Manufacturer

Company: CDS Technologies  
Address: PO Box 249  
Ashburnham, MA 01430  
Telephone: (978) 827 2378  
Fax: (978) 827-2388  
Email: nreitzal@CDStech.com  
Website: www.CDStech.com

### 5.1.3. Downstream Defender™

#### General Description

The Downstream Defender™ is a treatment device provided by Hydro International that augments gravitational forces with vortex forces to maximize solids/liquids separation. The Downstream Defender™ is self-activating and operates on fluid hydraulics. The geometry of the internal components and placement of the inlet and outlet pipes are designed to direct the flow in a pre-determined path through the vessel. Stormwater is introduced tangentially into the side of the vessel and initially spirals around the perimeter, where oil and floatables rise to the water surface and are trapped. As the flow continues to rotate about the vertical axis, it travels down toward the bottom of the dip plate. Sediment is directed toward the center and base of the vessel where it is collected in the sediment storage facility, beneath the vortex chamber. The center cone protects stored sediment and redirects the main flow upwards and inwards. By the time the flow reaches the top of the vessel, it is virtually free of solids and is discharged through the outlet pipe.



#### Site Considerations

The Downstream Defender™ was engineered to target and capture settleable solids, floatables, oil and grease from stormwater runoff. Specific potential applications include:

- New development and retrofits
- Construction sites, industrial and commercial facilities
- Streets, roadways, and parking lots
- Vehicle maintenance wash-down yards
- Wetlands protection

Four standard sizes are available; each designed to treat a range of flows to a specific solids removal efficiency. Hydro International also offers custom designed units up to forty feet in diameter to meet specific performance criteria or for larger flow applications. Table 5.5 shows the design specifications for each standard unit.

Table 5.5. Design specifications for the Downstream Defender™ standard units.

Unit Diameter	Design Flow(1)	Design Capacity (2)	Oil Storage Capacity	Sediment Storage Capacity
(feet)	(cfs)	(gpm)	(gallons)	(cubic yards)
4	0.78/3.0	330/1,350	70	0.70
6	3.00/8.0	1,350/3,590	230	2.10
8	7.00/15.0	3,140/6,730	525	4.65
10	13.0/25.0	5,830/11,220	1050	8.70

## Installation

The Downstream Defender™ is delivered to the site completely fabricated, ready to be installed into the excavated hole and connected to the inlet and outlet piping. The unit is compact and can fit within an excavation trench guard. It consists of a concrete cylindrical vessel with polypropylene internal components and a stainless steel support frame. The concrete vessel is a standard manhole, installed below grade. Larger units are delivered to site in component form for final assembly at the job site. Installation time for a 6-foot unit is typically 1.5 hours. The Downstream Defender™ is a primary treatment device that requires no pretreatment. It can be used as a pretreatment device before detention systems, mitigating wetlands, or other polishing systems.

## Maintenance

The Downstream Defender™ should be installed in a location that is easily accessible for a maintenance vehicle, preferably in a flat area close to a roadway or parking area. Two ports at ground level provide access for inspection and cleanout of stored floatables and sediment. A commercially or municipally owned sump-vac is used to remove captured sediment and floatables. Floatables and oil should be removed prior to removal of sediment.

The frequency of maintenance is determined in the field, after inspection. During the first year of operation, the unit should be inspected every six months to determine the rate of sediment and floatables accumulation. A probe can be used to determine the level of solids in the sediment storage facility. When the sediment has accumulated to the specified depth, the contents should be removed by sump-vac. In most situations, it is recommended that the units be cleaned annually.

Although a small portion of the water is removed with the pollutants during the cleanout process, the units are typically not completely dewatered – minimizing disposal costs. The sump-vac procedure for a typical 6-foot diameter unit with one foot of sediment depth and two inches of oil and debris takes approximately 25 minutes and removes about 150 to 200 gallons of water in the process.

With regular maintenance, the Downstream Defender™ will treat stormwater for a period in excess of 30 years.

## Aesthetics, Community and Safety

Concerns regarding aesthetics, community support, and safety are highly site specific. For further information refer to Chapter 2, Decision Criteria.

## Cost

The Downstream Defender™ ranges in price depending unit size. The prices are as follows:

4' - diameter	\$10,200
6' - diameter	\$13,000
8' - diameter	\$19,000
10' - diameter	\$29,600

## Performance and Verification Ranking

Verification Ranking: ●●●●

Typical testing results show removal efficiencies of over than 90% of particles greater than 150 microns. Full-scale test results show settleable solids removal efficiencies of 90% at design flows. Because the sediment and oil storage areas are outside the main flow path through the unit, previously collected solids, oil and floatables are not re-entrained in the effluent during major storm events or surcharge conditions. In addition, treatment capacities are not reduced as pollutants accumulate between cleanouts.

Studies:

- *Swirl Concentrator Testing at Pinehurst Redmond, Washington.* Talaseae Consultants. October, 1999.
- The School of the Built Environment, Coventry University
- *State of Maine Performance Data and Testing Protocols Review.* April 1997 – September 1998.

## Installation Contact

Location: Shop N' Save Plaza, Manchester, NH  
 Contact: Art Grindle, Manchester Urban Pond Restoration Coordinator  
 City of Manchester  
 One City Hall Plaza  
 Manchester, NH 03101  
 Telephone: (603) 624-6450  
 Email: agrindle@ci.manchester.nh.us

## Manufacturer

Company: Hydro International  
 Address: 94 Hutchins Drive  
 Portland, ME 04102  
 Telephone: (207) 756-6200  
 Fax: (207) 756-6212  
 Email: hiltech@hil-tech.com  
 Website: www.hil-tech.com  
 Local contact: David Mongeau, Regional Sales Engineer  
 Email: dmongeau@hil-tech.com

### 5.1.4. Stormceptor®

#### General Description

The Stormceptor® is a precast modular structure that can be installed on existing or new storm drain systems. Its design prevents the resuspension or scouring of previously collected pollutants and it will not flush out previously collected materials during peak stormwater flow periods. The Stormceptor® units are made out of either fiberglass or precast concrete depending on site conditions.



#### Site Considerations

The Stormceptor® is designed for the removal of free-floating oil, grease, and sediments. It can be used as a primary water quality device, a pretreatment device, a spill control device, a coastal zone management device, or a stormwater device.

The Stormceptor® is best suited for drainage areas less than 10 acres. The fiberglass units are typically lighter in weight than the precast concrete units, and are chemically inert making them more suitable for installation at industrial sites, fuel tank farms, service stations, and restaurant parking lots. The precast concrete units are more suitable for residential subdivisions, commercial parking lots, and on roadway and highway margins.

The Stormceptor® is available in a choice of materials depending on treatment needs and site conditions. Dimensions of the systems vary from the Model STC900, which treats up to 285 gpm with a total holding capacity of 950 gallons, to a Model STC 7200, which treats up to 1110 gpm with a total holding capacity of 7415 gallons.

#### Installation

The Stormceptor® is assembled from precast modular components. Typically installation takes from several hours to ½ day. Installation is below grade. The Stormceptor® does not require any pretreatment and can be used as a pretreatment device for TSS removal and as a spill control device for removing oil and grease.

#### Maintenance

It is recommended that material in the storage section be pumped out annually by a vacuum truck, although monitoring may indicate that the unit needs less frequent service. Typical cleaning costs are estimates at approximately \$250, with disposal costs averaging \$300 to \$500. The absence of filtering media reduces the difficulty of maintenance. Stormceptor® units have an expected life of 50 to 100 years.

#### Aesthetics, Community and Safety

Concerns regarding aesthetics, community support, and safety are highly site specific. For further information refer to Chapter 2, Decision Criteria.

#### Cost

The cost of the Stormceptor® ranges from \$7600 for the STC 900 unit to \$33,560 for the STC 7200 unit. This price structure is for the entire unit, including lubricants and gaskets, flexible pipe connectors, and an HS20 Stormceptor® ring and lid. This price is not dependent on the height of the structure.

## Performance and Verification Ranking

Verification Ranking: ●●●●●

A variety of performance testing has been conducted on the Stormceptor®. Laboratory and field testing have shown removal efficiencies of 80% for TSS and 95% for free oil and hydrocarbon spills.

Studies:

- *Field Monitoring Results Seatac, Washington.* Associated Earth Sciences, Inc. March – October, 1999.
- *Field Monitoring Results Westwood, Massachusetts.* Environmental Sampling and Technology. July-November, 1997.
- *The School of the Built Environment Coventry University Stormceptor Report.* Coventry University. May-August, 1996.
- *Field Monitoring Results – Update Como Park, Minnesota.* Service Environmental and Engineering. August, 1998 – September, 1999
- *Massachusetts Strategic Envirotechnology Partnership (STEP) Program Stormceptor Report.* December 1997.
- *Stormceptor ¼ Scale Laboratory Test* National Water Research Institute. 1993, 1994.
- *Wisconsin Stormceptor Field Monitoring Summary.* Wisconsin Department of Natural Resources and US Geological Survey. August 1996 – April 1997.
- *Field Monitoring Results City of Edmonton, Alberta.* The Phoenix Group. 1994.
- *Sludge Analysis and Particle Size Distribution City of Orlando, Florida.* City of Orlando. June, 2000.

## Installation Contact

For information of installation contacts and updates please contact Rinker Materials. The following is a list of Stormceptor installation sites in New England:

Allenstown, NH  
Durham, NH  
Highland Ave, Hampton, NH  
Old Navy Store, Nashua, NH  
Gilmore Bridge, Boston, MA  
University Ave, Westwood, MA

South Bay Complex, Boston, MA  
Summerfield Suites, Burlington, MA  
Cardinal Honda, Groton, CT  
Clinton Crossing, Clinton, CT  
EPA Superfund Site, Stratford, CT

## Manufacturer

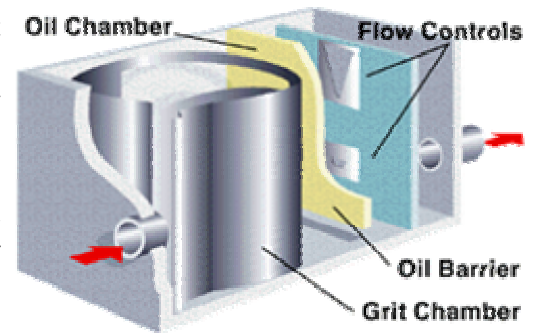
Company: Rinker Materials  
Hydro Conduit Division  
Address: 69 Neck Road  
Westfield, MA 01085  
Telephone: (800) 909-7763  
Fax: (816) 802-3871  
Website: [www.rinkerstormceptor.com](http://www.rinkerstormceptor.com)  
Contact: Jim Donovan, P.E., Stormceptor Marketing Manager  
Email: [jdonovan@rinker.com](mailto:jdonovan@rinker.com)

### 5.1.5. Vortechs™ Stormwater Treatment System

#### General Description

The Vortechs™ Stormwater Treatment System is designed to treat stormwater runoff from urban and other areas with impervious surfaces that threaten to drain pollutants into watersheds and other ecologically sensitive areas.

The Vortechs™ units are fabricated of a precast Portland cement mixture with a tangential inlet to the trap's circular grit chamber where stormwater is channeled into a vortex-like flow path. This swirling action directs sediment into the center of the chamber, where it accumulates. A sealed oil barrier then traps oily contaminants floating in the grit chamber. This combination of swirl-concentrator and flow-control technologies work to abate forces that encourage resuspension and washout.



#### Site Considerations

The Vortechs™ system is designed to remove and retain sand, hydrocarbon-laden sediments, petroleum-based liquids, and other floatable and settleable debris from stormwater runoff. Vortechs™ systems have been installed in a variety of residential, industrial, commercial, and municipal applications. Specific potential applications include:

- Parking lots
- Airport runways
- Roadways
- Vehicle maintenance areas
- Gas stations
- Outdoor material storage areas

Each Vortechs™ system is custom-designed to suit individual site conditions. Nine standard models of the Vortechs™ system are available. Treatment capacities range from the Model 1000, which treats up to 1.6 cfs, to the Model 16,000, which treats up to 25 cfs. Large flows can be accommodated using a combination of standard models with custom-sized or cast-in-place systems.

#### Installation

The Vortechs™ system is made of a precast Portland cement mixture. The circular grit chamber, and weir and orifice plates located on the flow-control wall, are fabricated separately of aluminum and installed by the precaster. Each Vortechs™ system also includes manhole frames and covers. Dimensions of the units range from the Model 1000, which is 9'l x 3'w x 6'h, to the Model 16,000, which is 18'l x 12'w x 8'h.

The Vortechs™ system is installed below grade. Installation time is approximately 3 hours. The excavation floor is leveled and lined with gravel or other granular material, and the Vortechs™ system housing and its components are lowered into place. Joints are then sealed, inlet and outlet piping are set in place, a cover is placed over the system and sealed, and the excavation is filled. Since each system is custom-engineered, inlet and outlet configurations can be modified to suit site conditions. Pretreatment of runoff before it enters the Vortechs™ system is not necessary in most cases.

## Maintenance

The system's flow controls cause water to decant at a controlled rate after a storm event, leaving a low water level. This, combined with the system's large pollutant storage capacity, results in a low water-to-pollutant ration. This typically reduces the cost and frequency of maintenance. Vortechtechnics recommends seasonal inspections during the first year of operation to establish an appropriate maintenance schedule. Typically the system is cleaned once per year depending upon weather and site activity. It is recommended that the maintenance schedule for New England installations include cleanout just prior to the winter sanding/salting season.

With regular maintenance the Vortechs™ system is designed to provide indefinite stormwater treatment. There are no moving parts, filters, bags, or other components that need to be replaced.

## Aesthetics, Community and Safety

Concerns regarding aesthetics, community support, and safety are highly site specific. For further information refer to Chapter 2, Decision Criteria.

## Cost

The cost of the Vortechs™ system ranges from approximately \$8,900 for the model 1000 to \$40,000 for the model 16000. An additional 30% for the smaller units and 50% for the larger units can be estimated for installation costs. Sizing and pricing the system is done on an individual basis to accommodate local site conditions and treatment requirements; contact Vortechtechnics for assistance with sizing and pricing for specific projects. Prices include manhole frames and covers, but exclude risers (if needed) and excavation and installation costs. Typically the site contractor, who can provide cost estimates for these services, undertakes the latter two items.

## Performance and Verification Ranking

Verification Ranking: 

Laboratory studies of the Vortechs™ system showed a “net” total suspended solids (TSS) removal efficiency rate over the course of storm events of over 80%. In-field monitoring and testing is ongoing; preliminary test results are available from Vortechtechnics upon request.

Studies:

- *Vortechtechnics Stormwater Treatment Study*. Susan Kluk, University of Connecticut. January 1998 to August 2000.
- *A Study of the Effectiveness of a Vortechs Stormwater Treatment System for Removal of Total Suspended Solids and Other Pollutants in the Marine Village Watershed, Village of Lake George, New York*. NYS Department of Environmental Conservation Division of Water. January 2001.
- *Stormwater Treatment Demonstration Project Oil Water/Grit Separator followed by a Sand Filter*. Harding Township, NJ. A. Roger Greenway, RTP Environmental Associates.
- *Technology Assessment Report Vortechs Stormwater Treatment System Vortechtechnics, Inc.* Scarborough, ME. Prepared for Massachusetts Strategic Envirotechnology Partnership (STEP). Eric Winkler, Ph.D. and Susan Guswa, PE. October 31, 2002.

### Installation Contact

Location: Mast Landing, Wolfeboro, NH  
Date Installed: November, 2000  
Contact: Marty Bilafer, Director of Public Works  
PO Box 629  
Wolfeboro, NH 03894  
Tel: (603) 569-8176

#### Additional Installations:

Lake Tahoe, CA  
Lake Beseck, Middlefield, CT  
Penobscot River, Bangor, ME  
Ropes Beach, Cotuit, MA  
Lake Williams, Marlborough, MA  
Jones River, Kingston, MA  
Lake of the Lillies, Point Pleasant, NJ  
Lake Winnepesaukee, Meredith, NH  
Dublin Lake, Dublin, NH

### Manufacturer

Company: Vortechtechnics, Inc.  
Address: 200 Enterprise Drive  
Scarborough, Maine 04074  
Telephone: (207) 885-9830  
Fax: (207) 885-9825  
Website: [www.vortechtechnics.com](http://www.vortechtechnics.com)

### 5.1.6. HYDRASEP®

#### General Description

The Hydrasep® oil/water separator is designed to operate as a flow through device and to separate immiscible liquids by gravity in either a batch flow or continuous flow process. The contaminated liquid is introduced into the inlet or Mixing Chamber where heavy solids are allowed to settle. The flow then enters into the Separator Chamber, which consists of a series of channels, sub-divided into multiple parallel sub-channels. These serpentine channels direct the flow and eliminate turbulence. The transfer pipe connecting the separator section to the clean water section regulates and dampens fluid accelerations, causing the separator to act as an accumulator. The Oil Section is a separate area for retention and removal of accumulated oils without interfering with the operation of the separator. The Clean Water Section is designed for gravity discharge of water.

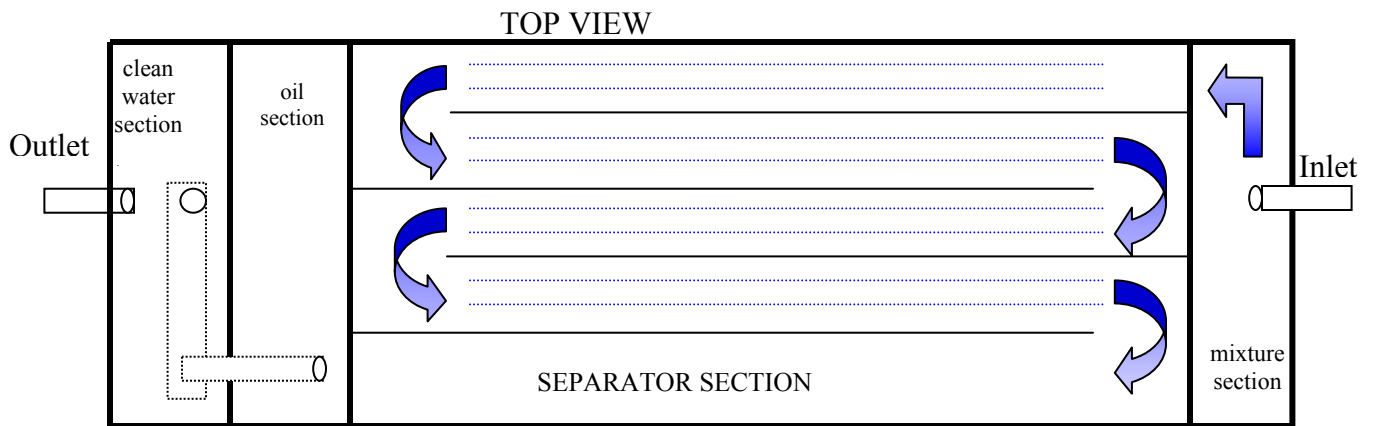


Figure 5.1. Top view of HYDRASEP Rectangular Oil/ Water Separator.

#### Site Considerations

The Hydrasep® system is designed to target and remove oil and grease from stormwater runoff. The Hydrasep® can be used for a variety of applications requiring gravity separation of immiscible liquids. Specific potential applications include:

- Railroads, airports, and bus terminals
- Truck stops
- Parking lots
- Marinas and dock operations
- Municipal vehicle and Industrial facilities

The Hydrasep® Oil/Water Separator is available in a variety of models depending on individual site conditions. Models include: the Effluent Pump-Out Model, the Combination Interceptor and Oil/Water Separator Model, the Oil/Water Separator Model, and the Grade Service Access Model. Hydrasep® systems can treat a range of flows from the Model HS 550-UG, which treats flows up to 55 gpm and holds up to 550 gallons, to the Model HS 20,000-UG, which treats flows up to 2,000 gpm and holds up to 20,000 gallons.

## Installation

The Hydrasep® Underground Oil/Water Separators are constructed of corrosion-protected steel and are installed below grade. The units range in size from the Model HS 550-UG, which is 3'6" in diameter and 8'2" in length, to the Model 20,000-UG, which is 9'3" in diameter and 40'4" in length. No pretreatment is required for the Hydrasep® system.

## Maintenance

Gnesys recommends monthly inspections of the control unit, and an annual visual inspection of the separator. This annual inspection requires the removal of three manway hatches and observation of the liquids within these sections. The annual inspection should take 30 to 60 minutes, depending on the type and location of the installation.

## Aesthetics, Community and Safety

Concerns regarding aesthetics, community support, and safety are highly site specific. For further information refer to Chapter 2, Decision Criteria.

## Cost

The average cost of the Hydrasep® system Model HS 1000-UG is \$9,000.00.

## Performance and Verification Ranking

Verification Ranking: ●●●

Testing of the Hydrasep® Oil/Water separator has shown removal efficiencies of over 99.9% of oil and grease. Testing has shown that Hydrasep® maintains efficiency with mixtures up to 500,000 parts per million (ppm), and has shown performance of 10 ppm or less.

Studies:

- The University of Memphis. Global Engineering Consultants. 1995.

## Installation Contact

No existing New Hampshire installations to date. For contact information of installations outside of New Hampshire and for updates please contact Gnesys, Inc.

## Manufacturer

Company: Gnesys, Inc.  
Address: 2147 Frisco Avenue  
Memphis, TN 38114  
Telephone: (800) 646-5439 or (901) 745-4503  
Fax: (901) 745-4507  
Email: sales@hydrasep.com  
Website: www.hydrasep.com  
Contact: Naji Nassif, PhD

### 5.1.7. Aqua-Swirl™ Concentrator

#### General Description

The AquaSwirl™ Concentrator is a swirl separator typically installed in an “off-line” configuration. Stormwater enters the swirl concentrator by means of a tangential inlet pipe that creates a circular flow pattern. A combination of gravitational and hydrodynamic drag forces cause solids to drop out of the flow and migrate to the center of the chamber where velocities are lower. The velocity gradient created by the swirling action prevents solids from being re-suspended.



#### Site Considerations

The AquaSwirl™ Concentrator targets and removes sediment and free-floating oil and debris from stormwater runoff. Specific potential applications include:

- Retail/commercial developments
- New and existing industrial facilities
- Highway and transportation facilities
- Watershed protection
- Redevelopment/retrofit sites
- Fast food restaurants
- Coastal communities

The AquaSwirl™ Concentrator is fabricated using High-Density Polyethylene (HDPE) materials. Table 5.6 below shows the standard AquaSwirl Models and the associated treatment and storage capacities.

Table 5.6. AquaSwirl models and associated treatment and storage capacities.

Aqua-Swirl™ Model	Peak Design Storm Flow (i.e. Q10-yr) (cfs)	Swirl Chamber Diameter (ft)	Approximate Impervious Area Treated (acres)	Oil Storage Capacity (gal)	Sediment Storage Capacity (yd <sup>3</sup> )
AS-3	5.25	3.5	0.00 – 0.75	85	0.75
AS-4	10.5	4.5	0.75 – 1.50	150	1.25
AS-6	18	6	1.50 – 3.00	300	2.5
AS-7	26	7	3.00 – 4.25	425	3.5
AS-8	34	8	4.25 – 5.50	550	4.5
AS-9	42	9	5.50 – 7.00	700	5.5

#### Installation

The AquaSwirl™ Concentrator is delivered to the job site ready for inspection and use. Typical installation steps include preparation and excavation of the installation area. The swirl concentrator is made of lightweight HDPE, which can be offloaded without the need of special lifting equipment. The AquaSwirl™ Concentrator includes inlet and outlet stub-outs, which connect to existing piping to ensure correct inlet angle, and all connections are typically joined by heat fusion. No pretreatment is required for the AquaSwirl™ Concentrator.

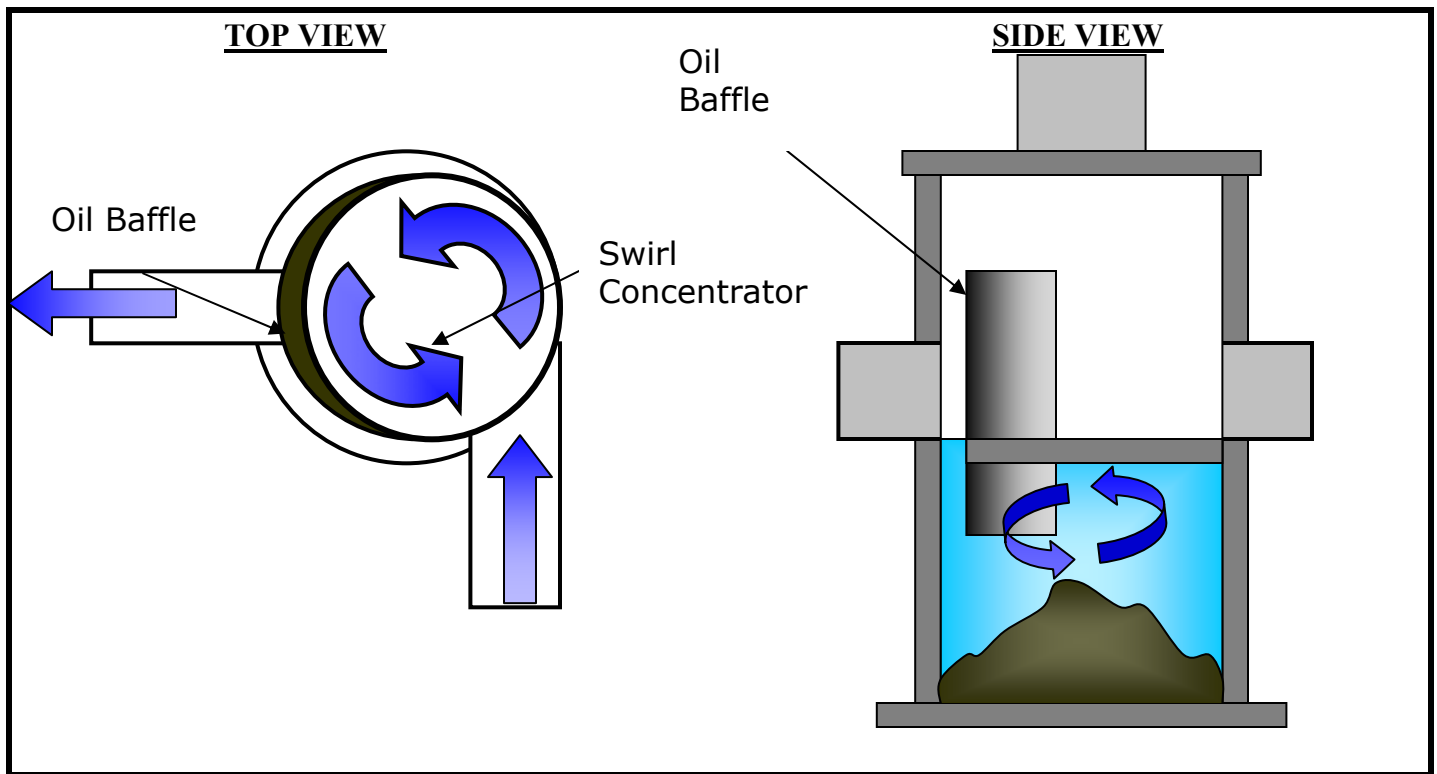


Figure 5.2. Top and side views of the AquaSwirl Swirl Concentrator.

### Maintenance

It is important that a routine inspection and maintenance program is established for each unit based on the volume of the contaminants of concern, the frequency of contaminant release at the location, and the nature of the area being drained. AquaShield, Inc. assists customers with establishing an inspection and maintenance program for compliance with stormwater pollution prevention plans.

AquaShield, Inc. recommends that semi-annual inspections of the Swirl Concentrator be performed for the first year of operation in order to develop an appropriate maintenance schedule for the site. Typically, annual cleanout is required in colder climates where sediment loads tend to accumulate more rapidly due to sanding practices.

#### Swirl Concentrator Chamber Cleanout Procedure:

The AquaSwirl system can be inspected and maintained completely from the surface to eliminate the need for confined space entry. Free-floating oil and debris can be directly observed and maintained through the 28" manhole access provided over the center of the swirl chamber.

Cleanout of accumulated sediment needs to be performed when the useable sediment storage volume has been occupied. Sediment depths can be determined by measuring the distance from the top of the sediment pile to the water's surface by lowering a measuring device, and determining the difference in elevations. Specifically, when the sediment pile is within 24" of the water surface, the system should be pumped clean.

Normally, a high velocity vacuum truck is used to clean the collected pollutants within the system. The vacuum hose is lowered into the sediment pile for its removal.

### Aesthetics, Community and Safety

Concerns regarding aesthetics, community support, and safety are highly site specific. For further information refer to Chapter 2, Decision Criteria.

### Cost

The average cost of the AquaSwirl™ Concentrator is based on the size of the unit and the treatment capacity. Table 5.7 summarizes the average standard unit costs according to size.

Table 5.7. Average cost of the AquaSwirl™ Concentrator based on standard models.

<b>AquaSwirl™ Model</b>	<b>Cost</b>
AS-3	\$7500
AS-4	\$9000
AS-6	\$14,000
AS-7	\$17,000
AS-8	\$20,500
AS-9	\$28,500

### Performance and Verification Ranking

Verification Ranking: **0**

To date there is no available performance verification information for the AquaGuard™ Catch Basin Insert. Contact AquaShield, Inc. for updates in performance studies.

### Installation Contact

No existing New Hampshire installations to date.

Location: Essex, Vermont  
 Contact: Jeremy Matosky  
 Trudell Consulting Engineers  
 PO Box 308  
 478 Blair Park Road  
 Williston, VT 05495  
 (802) 879-6331

### Manufacturer

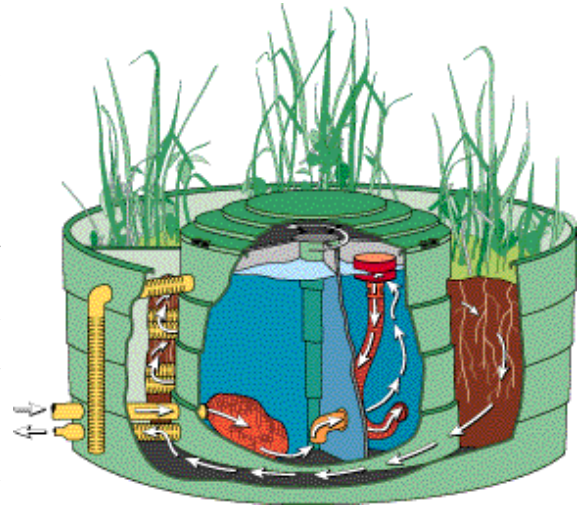
Company: AquaShield, Inc.  
 Address: 2733 Kanasita Drive, Suite A  
 Hixon, TN 37343  
 Telephone: (423) 870-8888 or (888) 344-9044  
 Fax: (423) 870-1005  
 Website: [www.aquashieldinc.com](http://www.aquashieldinc.com)

## 5.2. Retrofit Constructed Wetland Device

### 5.2.1. StormTreat™

#### General Description

The StormTreat™ System consists of a series of six sedimentation chambers and a constructed wetland, which are contained within a modular tank. Influent is piped into the sedimentation chambers where larger-diameter solids are removed. The internal sedimentation chambers contain a series of skimmers that decant the upper portions of the stormwater sediment basins, leaving behind more turbid lower waters. After moving through the internal chambers, the partially treated stormwater passes into the surrounding constructed wetland through a series of slotted PVC pipes.



The wetland is comprised of a gravel substrate planted with bulrushes and other appropriate wetland plants. StormTreat™ conveys stormwater into the subsurface of the wetland and through the root zone, where pollution attenuation occurs through such processes as filtration, adsorption, and biochemical reactions.

#### Site Considerations

The StormTreat™ System targets and removes solids, oil and greases, metals, and phosphorus. This system also provides microbial decomposition to treat stormwater runoff and associated pollutants. In addition, an outlet control valve can be closed to contain hazardous spills. StormTreat™ Systems have been installed in a variety of application, including both coastal and inland areas. Specific potential applications include:

- Commercial parking lots
- Industrial sites
- Town landings and marinas
- Transportation facilities
- Residential subdivisions

The StormTreat™ System is constructed of recycled polyethylene. Typically, 1-2 tanks are required per acre of impervious surface. The number of tanks is dependent on the level of treatment required, in-line detention capacity, and use of the optional infiltration feature, which provides an internal weir that directs treated water into the surrounding fill and soils once the water level in the wetland reaches three feet. The StormTreat™ storage capacity is 1390 gallons, with an average detention time of 5 days and an average discharge rate of 1-5 gallons per minute (gpm).

#### Installation

The StormTreat™ modular tank is 9.5 feet in diameter and is 4 feet in height. The low discharge rate (1-5 gallons per minute (gpm)) enables the system to be installed in any type of soil, however, because the system is gravity-dependent, the system requires an elevation change from the pavement surface to the

discharge point of at least 4 feet. The manufacturer recommends that a catch basin be placed upstream, prior to the StormTreat™ System in order to provide pretreatment and to trap larger diameter sediments.

### Maintenance

Annual inspection is recommended to ensure that the system is operating effectively. At that time, the manhole should be opened and the burlap grit-screening bag covering the influent line should be removed and replaced. Filters should be removed, cleaned, and reinstalled. Sediment should be removed from the system via vacuum pump once every 3-5 years, depending on local soil characteristics and catch basin maintenance practices. The life expectancy of the StormTreat™ System is 20+ years upon proper maintenance.

### Aesthetics, Community and Safety

Concerns regarding aesthetics, community support, and safety are highly site specific. For further information refer to Chapter 2, Decision Criteria.

### Cost

The price per tank for the StormTreat™ System is approximately \$6,500. Additional materials required include gravel, piping, and wetland plants at an average of \$350 - \$400 per tank. Installation costs vary from \$100 - \$500 per tank for new construction and \$500 - \$1,500 per tank for retrofits. Average cost per acre of contributing impervious drainage area are \$7,500 - \$15,000.

### Performance and Verification Ranking

Verification Ranking: ●●●●●

To date, eight independent storm events have been monitored during both winter and summer New England conditions. The Commonwealth of Massachusetts Strategic Envirotechnology Partnership (STEP) Program has verified the system performance.

Studies:

- *Treatment of Parking Lot Stormwater Using a StormTreat System.* University of Connecticut Department of Natural Resources Management and Engineering. 1997.
- *Progress Report Water Quality Monitoring at Elm Street Facility Kingston, Massachusetts.* StormTreat Systems, Inc. 1995.
- The Massachusetts Strategic Envirotechnology Partnership (STEP) Program. September 1997.

### Installation Contact

Location: Crystal Lake, Manchester, NH  
 Contact: Art Grindle, Manchester Urban Pond Restoration Coordinator  
 City of Manchester  
 One City Hall Plaza  
 Manchester, NH 03101  
 Telephone: (603) 624-6450  
 Email: agrindle@ci.manchester.nh.us

StormTreat™ Systems have also been installed at the following locations:

- GTE Laboratores, Waltham, MA
- Housing Development, Auburn, MA
- Mill Pond, Barnstable, MA
- New England Sealcoating, Hingham, MA
- Residential Road, Jones River, Kingston, MA
- Residential Road, Rowley, MA
- Shell fishing area, Gloucester, MA
- Town Park, Ipswich, MA
- Rite-Aid, Augusta, ME
- Rite-Aid, Manchester, ME

### Manufacturer

Company: StormTreat Systems, Inc.  
Address: 124 Route 6A  
Sandwich, MA 02563  
Telephone: (508) 833-1033 or (877)-STRMH2O (toll free)  
787-6426  
Fax: (508) 833-1033  
Email: [info@stormtreat.com](mailto:info@stormtreat.com)  
Website: [www.stormtreat.com](http://www.stormtreat.com)

## 5.3. Filtration Systems

### 5.3.1. Aqua-Filter™ Stormwater Filtration System

#### General Description

The AquaFilter™ Stormwater Filtration System is an in-line stormwater filtration system, which includes a Swirl Concentrator followed by a Filtration chamber with cellulose filter media. Stormwater enters the Swirl Concentrator™ by means of a tangential inlet pipe that induces a circular flow pattern. The swirling action encourages solids to drop out of the chamber, thereby preventing resuspension. A baffle plate located in front of the outlet to the Swirl Concentrator™ traps free-floating oil and debris. The pretreated flow then enters the filtration chamber where it is distributed across the filter media and allowed to permeate.



#### Site Considerations

The AquaFilter™ System is designed to target and remove fine sediments, free-floating oil and debris, soluble and insoluble hydrocarbons (oil and grease), phosphorus and nitrogen, volatile organic compounds, PCB's, and various organically bound heavy metals (i.e. lead, copper, zinc, chromium).

The AquaFilter™ System is capable of treating large flow rates. Larger, less frequent storms (i.e. 2-year, 10-year, or 25-year) are treated in the Swirl Concentrator™, and then allowed to partially by-pass the filter media internally beneath the filter bed. Standard AquaFilter™ models are summarized below in Table 5.8.

Table 5.8. AquaFilter™ standard models.

AquaFilter™ Model	Peak Design Flow (cfs)	Approx. Area Treated (acres)	Diameter(ft)
AF-4.5	3.5	0.5-1.0	3
AF-6	5.0	1.0-2.0	4
AF-7	7.5	2.0-3.0	6
AF-8	11.0	3.0-4.5	8
AF-9	14.5	4.5-6.0	9

#### Installation

The AquaFilter™ System is made of lightweight High-Density Polyethylene (HDPE) material, and can be off-loaded without the need of special lifting equipment. Because the initial stage of the AquaFilter™ System incorporates a Swirl Concentrator™, no pretreatment is required prior to the system. The Swirl Concentrator™ acts as a pretreatment device for removing coarse/fine sediment and free-floating oil and debris.

## Maintenance

A routine inspection and maintenance program is recommended by the manufacturer and should be established for each unit based on the volume or load of the contaminants of concern, the frequency of releases of contaminants, and the nature of the area being drained. Over time the filter media changes color as it accumulates pollutants, allowing for inspection from the surface. When the media's color changes from tan to black, it needs to be replaced.

**Pretreatment Chamber:** The Swirl Concentrator™ is inspected from the surface. Free-floating oil and debris is observed by removing the manhole cover. Sediment depth is determined by lowering a measuring device to the top of the sediment pile.

**Filtration Chamber:** 30-inch diameter manholes are spaced over the entire filter bed providing access for inspection and removal of the filter media. Filter media is replaced by removing spent bags and positioning replacement filter bags into the filter bed.

AquaShield™ offers a complete maintenance package. Included in the maintenance services is a full inspection program (typically quarterly). If the field inspection shows that either the unit needs cleaning or the filter media needs to be replaced, a maintenance crew will be sent to the site to perform appropriate maintenance. A written report can be submitted to the regulating agency based upon the inspection observations and what, if any maintenance was performed.

## Aesthetics, Community and Safety

Concerns regarding aesthetics, community support, and safety are highly site specific. For further information refer to Chapter 2, Decision Criteria.

## Cost

The average cost of the AquaFilter™ Concentrator is based on the size of the unit and the treatment capacity. The standard units are priced according to size and range from \$25,000 to \$69,000 per unit. The average cost of replacement filter bags is \$45 per bag.

## Performance and Verification Ranking

Verification Ranking: ●●●●

AquaShield, Inc. has and is continuing to participate in both manufacturer and independent testing of controlled laboratory and uncontrolled field conditions for technology performance effectiveness in removing pollutants found in stormwater runoff. The performance of the AquaFilter™ System technology has recently been verified by the California Environmental Protection Agency's Environmental Technology Certification Program (cert. #00-03-001) for the removal of 90% - 95% of dissolved petroleum and oils. Third party monitoring of the AquaFilter™ system showed removal rates of up to 88.9% TSS, 98.9% dissolved petroleum and oils, and reductions in phosphorus and nitrogen.

Studies:

- *AquaShield System*. Analytical Industrial Research Laboratories, Inc. September 1997.
- Environmental Technology Evaluation Center (EvTEC) through the Civil Engineering Research Foundation (CERF) of the American Society of Civil Engineers (ASCE)
- U.S. EPA/NSF International – Wet Weather Flow Technologies Pilot (WWF) of the Environmental Technology Verification (ETV) Program

- California EPA – Environmental Technology Certification Program (ETC) or CalCert
- U.S. Navy Environmental Leadership Program (NELP)
- City of Los Angeles, CA – Dept. of Public Works, Stormwater Management Division – TEA 21 Urban Stormwater Management Program
- City of Chattanooga, TN, Dept. of Public Works, Stormwater Management Division
- City of Jackson, WY, Dept. of Public Works, Stormwater Management Division

### Installation Contact

No existing New Hampshire installations to date.

Location: DPW Yard, Wayne, MI

Contact: Ron Cavallaro  
Ayres, Lewis, Norris and May, Division of the Keith Companies  
Ann Arbor, MI  
(734) 761-1010  
rcavallaro@alnm.com

### Manufacturer

Company: AquaShield, Inc.  
Address: 2733 Kanasita Drive, Suite A  
Hixon, TN 37343  
Telephone: (423) 870-8888 or (888) 344-9044  
Fax: (423) 870-1005  
Website: [www.aquasieldinc.com](http://www.aquasieldinc.com)

### 5.3.2. StormFilter™

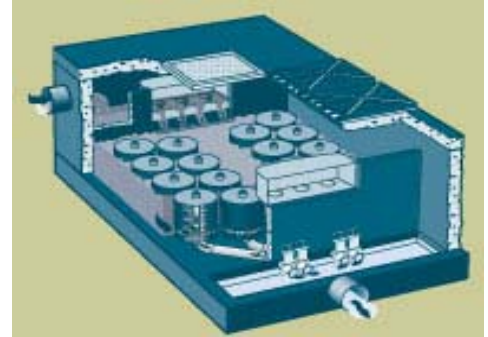
#### General Description

The StormFilter™ is a passive, flow-through stormwater filtration system that utilizes rechargeable filter cartridges. The siphon-driven cartridges, which draw stormwater through the filter media, are installed in precast or cast-in-place concrete vaults with pipe underdrains cast into the concrete floor.

#### Site Considerations

The StormFilter™ system is designed to remove total suspended solids (TSS), soluble metals, soluble phosphorus, nitrates, and oil and grease through mechanical filtration, ion exchange, and adsorption. The StormFilter™ has the option of filter media, which is selected based on the target pollutants at the site. Specific potential applications include:

- Fast food and shopping mall parking areas
- Medical facilities
- Light industrial developments
- Arterial roadways
- Residential roadways
- Freeway systems
- Waste transfer stations



The StormFilter™ is sized to treat the peak flow of a water design storm as it passes through the system. The number of filter cartridges required to treat the peak water quality flow determines the particular size of a system. Each cartridge is designed to treat a peak flow of 15 gpm (30 cartridges/cfs). The StormFilter™ cartridge is the primary treatment device within the system. The cartridges are filled with various media depending on individual site conditions. The five types of media are described below:

CSF® Leaf Media: From pure deciduous leaves, composted, and pelletized.

Granular Activated Carbon (GAC): From a coal based media.

Iron-Infused Media: From an open cellular porous foam media that contains iron within its structure.

Perlite: From a naturally occurring volcanic ash, expanded rapidly by heat.

Zeolite: From naturally occurring Clinoptilolite.

Pleated Fabric Insert: Constructed from 75 feet<sup>2</sup> of polyester material with pore openings of either 37 or 70 microns.

#### Installation

Stormwater Management provides a full range of engineering services for the design of the StormFilter™. Stormwater Management also provides all components to the StormFilter™, cartridge installation, and final observation. In addition, Stormwater Management provides long-term support and maintenance to the land owner/operator.

The StormFilter™ typically requires 2.3 feet of head differential between the invert of the inlet and the invert of the outlet. Detailed construction specifications are available from the manufacturer. Pretreatment needs vary depending on site characteristics. Examples of upstream practices include:

- Pavement sweeping and other source control measures
- Trapped and sump catch basins
- Detention ponds, vaults, or pipes
- Sediment forebays
- Oil-water separators and hydrodynamic devices

### Maintenance

Inspections are recommended during the mid-season to determine the system loading. Annual maintenance is recommended, and should be incorporated into the stormwater management plan for the entire site. Typical maintenance involves sediment removal and cartridge removal and recharging as necessary. Operations and maintenance guidelines are available from Stormwater Management. The company also provides maintenance services, site assessments, and notification to regulatory agencies when the units are maintained and are in compliance. Stormwater Management can provide full maintenance (sediment removal from entire vault, replacement of existing cartridges with recharged cartridges, sediment and media disposal, and letter and certificate of compliance) at an average cost of \$100 per cartridge. Structural design is on the order of 50 years. Cartridge life is guaranteed as long as maintenance contract is upheld. The typical life of a cartridge is 20 years.

### Aesthetics, Community and Safety

Concerns regarding aesthetics, community support, and safety are highly site specific. For further information refer to Chapter 2, Decision Criteria.

### Cost

System costs vary depending on structural needs, depth, type of lid, and other factors. A 6' x 12' StormFilter™ (filters a flow-through volume of 0.3 cfs) will cost approximately \$15,000. An 8' x 18' StormFilter™ (filters a flow-through volume of 0.8 cfs) will cost approximately \$30,000. Larger units, capable of filtering flow-through volumes of greater than 0.8 cfs, range in price from \$30,000 to \$200,000.

### Performance and Verification Ranking

Verification Ranking: ●●●●

Independent and laboratory studies have been conducted on the StormFilter™ system and are available from the Stormwater Management website. Data include removals of TSS, ortho-phosphorus, oil and grease, total phosphorus, soluble metals such as copper and zinc, and other pollutants such as pentachloro-phenol. Water characterization studies are available for specialized applications.

Studies:

- *Stormwater Sampling – StormFilter Performance Results*. Burwell/Straley's Union 76 Station, Bremerton, Washington. EnCo Environmental Corporation April 2001 – August 2001.

## Installation Contact

No existing New Hampshire installations to date. For contact information of installations outside of New Hampshire and for updates please contact Stormwater Management, Inc.

### Additional Installations:

California	Kansas	North Carolina	Washington
Colorado	Maryland	Ohio	Washington, DC
Delaware	Montana	Oregon	
Florida	New Jersey	Vermont	
Idaho	New Mexico	Virginia	

## Manufacturer

Company: Stormwater Management, Inc.  
Address: 12021B NE Airport Way  
Portland, OR 97220  
Telephone: (800) 548-4667  
Fax: (800) 561-1271  
Website: [www.stormwaterinc.com](http://www.stormwaterinc.com)  
Contact: David Mailhot, P.E.  
Email: [davidm@stormwaterinc.com](mailto:davidm@stormwaterinc.com)

## 5.4. Patented Vegetated Swale

### 5.4.1. The Howland Swale

#### General Description

The Howland Swale® is a patented alternative detention structure for stormwater treatment. Collected runoff enters the Howland Swale via a siltation trap lined with large and then small riprap stone (crushed stone) that breaks up the flow velocity and traps larger-sized sediment particles. This trap also acts as a preliminary detention basin as water builds up in the basin prior to overflow on to the next stage.

The second stage, a pretreatment marsh, contains specialized plants to trap and absorb pollutants, increase percolation, and enhance water entrapment. Plant mixes vary, but typically include: cattails, arrow arum, arrowhead, hempweed, woolgrass, tapegrass, blue flag iris, and sphagnum moss.

The third stage is a vegetated storage chamber that provides for runoff control. Water then exits through a vegetated take-off channel, which allows for final washing, velocity reduction, and filtering of water before discharge.

#### Site Considerations

The Howland Swale® is designed to provide flow control and water quality treatment for stormwater runoff including removal of silts and other contaminants. It is appropriate for use in both commercial and residential development or runoff situations. The Howland Swale® is sized accordingly to the drainage area to be served.

#### Installation

Howland Swale® installations are custom-designed for site conditions. No pretreatment is required for the Howland Swale. Table 5.9 below shows the Howland Swale component specifications.



Table 5.9. Howland Swale component specifications.

<b>Silt basin</b>	1½' stone for splash point
	½" layer of peastone
	Basin lining of clay or erosion blanket
<b>Pretreatment marsh</b>	Hydric soils
	Cattails planted 2' on centers
	Tearthumb and hempweed rootstock for fringe area
	Soft rush and twig rush edging marsh and at outfall swale
	Arrow arum (seed, cutting, and bulb stock) for marsh entry point
	Tapegrass buffer
	Perennial aster and thistle for marsh slopes and berm sides
<b>Adjustment chamber</b>	4:1 slope planted with winter rye grass planting and erosion matting
	Basin bed may be seeded with sod
<b>Vegetated take-off channel</b>	Base bed 4 – 5'w x 25 – 50'l
	2:1 slope on channel sides with rye grass planting and erosion matting
	Channel base to be contoured with bumpy configuration using 1'w x 0.5'h sod covered clay berms
	Peat-filled capillary mats between berms to be planted with arrow arum, water clover, parrot's feather, and various rushes

### Maintenance

Maintenance guidelines can be obtained through contacting the manufacturer.

### Aesthetics, Community and Safety

Concerns regarding aesthetics, community support, and safety are highly site specific. For further information refer to Chapter 2, Decision Criteria.

### Cost

Howland Swale installations are custom-designed; costs depend on local site conditions and are individually quoted and typically range from \$400 to \$600. Actual construction costs, which include materials and plantings but do not include pre-construction design work, are approximately \$10 per linear foot.

### Performance and Verification Ranking

Verification Ranking: 

With most pollutants, 100% uptake ratios are achieved in the smaller storm events that carry the bulk of pollutants. TSS removals are in the order of 93% to 98%.

Studies:

- *Summary List of Howland Swale Operational Performance*. Environmental Research Corp. GTE Site, Waltham, MA. August 1998.

### Installation Contact

There are approximately 300 Howland Swale installations in Southern New England.

Location: Various installations

Contact: Bob Brady  
South Eastern Development Corporation  
(781) 293-6556

### Manufacturer

Company: Environmental Research Corps  
Address: 14 Mohawk Avenue  
East Freetown, MA 02717  
Telephone: (508) 763-5253  
Fax: (508) 763-8781  
Email: [mhowland@ma.ultranet.com](mailto:mhowland@ma.ultranet.com)  
Website: [www.howlandswale.com](http://www.howlandswale.com)  
Contact: Mark Howland

## 5.5 Catch Basin Systems

### Technical Note

Existing catch basins are typically designed by qualified engineers to be positioned and sized according to a predetermined amount of water at a minimum flow rate. This is done in order to provide efficient removal of water from a roadway. Catch basin inserts containing filter media may have the potential, particularly in retrofit situations when not previously included in flow calculations, to slow water flow and reduce overall capacity. Therefore, it is recommended that, before retrofitting existing catch basins with filter media inserts, calculations be conducted with a qualified engineer or site designer to determine flow rates and capacity. This will allow for engineers to determine the impact of filter media inserts on the existing system and ensure continued efficiency.

In addition, some catch basin systems may not be appropriate in areas of NH where leaves and sand may be a problem for maintenance. The manufacturer should be contacted directly by the client to determine the feasibility of product use for specific site conditions.

### 5.5.1. AbTech Ultra-Urban™ Filters with OARS® Onboard

#### General Description

The Ultra-Urban Filter™ with OARS OnBoard®, developed and manufactured by AbTech Industries, is designed for use in catch basin systems to treat stormwater. The Ultra-Urban Filter comes in two series. The series CO1414 is made of corrugated plastic and has perforated cut-outs on each side of the module at the top. These cut-outs allow for the creation of a lateral overflow of stormwater to additional treatment systems or, during high flow situations, for stormwater bypass. The AbTech Ultra-Urban Filter Series DI2020 suspends from the drain into the catch basin through a structural plastic mounting collar and funnel mechanism.

#### Site Considerations

The Ultra-Urban Filter is designed for use in storm drains to capture oil, grease, trash, and sediment from stormwater runoff before it enters the storm drain system. Trash and sediment accumulate in the internal basket while oil and grease are captured in the filtration media. The Ultra-Urban Filter can be used in municipal, industrial, and construction applications.

The drainage area being served determines the number and configuration of AbTech Ultra-Urban Filter inserts. Flow rates through the filters exceed 70 gpm for the CO1414 and greater than 110 gpm for the DI202 series at installation. A typical curb-style storm drain has three to five modules per drain.

#### Installation

The series CO1414 can be installed in approximately one hour through a maintenance access of at least 24 inches in diameter. A single mounting bracket made of 16-gauge steel is required for the installation. The bracket can be attached to any vertical surface capable of supporting 250 pounds. The series DI2020 can be installed in less than five minutes. The DI2020 series should not be installed in drains where modules obstruct the drainpipe outlet. No pretreatment is required for Ultra-Urban Filter use.

## Maintenance

Ultra-Urban Filters should be serviced as needed to remove sediment and debris, according to expected debris accumulation. When necessary, the sediment and debris should be vacuumed out of the module using conventional maintenance equipment. Under normal operating conditions, the entire recyclable filter box should be replaced every 1-3 years.

## Aesthetics, Community and Safety

Concerns regarding aesthetics, community support, and safety are highly site specific. For further information refer to Chapter 2, Decision Criteria.

## Cost

Table 5.10 below indicates product pricing for the Ultra-Urban Filter. Please contact AbTech Industries for product pricing updates.

Table 5.10. AbTech Ultra-Urban Filter price list.

Product Number	Description	Dimensions (l x w x h)	Packaging Per Unit	MSRP (FOB Factory)
CO1414	Ultra-Urban Filter Curb Opening Module	13"x14"x23"	1 unit	\$250.00
CO1414H	Ultra-Urban Filter Curb Opening Module	13"x14"x13"	1 unit	\$250.00
CO1414FD	CO1414 Flow Diverter	Various	Linear feet	\$10.00/ft
CO1414BK	CO1414 Mounting Bracket	Various	Linear feet	\$10.00/ft
DI2020	Ultra-Urban Filter Drain Insert Module	19"x19"x20.75"	1 unit	\$590.00
DI2020H	Ultra-Urban Filter Drain Insert Module	20"x20"x13"	1 unit	\$590.00
DI2020FN	DI2020 Collar	Various	1 unit	\$100.00
DI1414	Ultra-Urban Filter Drain Insert Module	13"x14"x20.75"	1 unit	\$400.00
DI1414H	Ultra-Urban Filter Drain Insert Module	13"x14"x13"	1 unit	\$400.00
DI1414FN	DI1414 Collar (round)	26" diameter	1 unit	\$100.00
DI1420	Ultra-Urban Filter Drain Insert Module	14"x20"x20"	1 unit	\$450.00
DI1420H	Ultra-Urban Filter Drain Insert Module	14"x20"x13"	1 unit	\$450.00
UUF Mount	Ultra-Urban Filter Mounting Accessories	Various		Cost plus 50%
PC-55	Smart Sponge Popcorn	n/a	55 lbs/carton	\$600.00
PT-50	Smart Sponge Powder	n/a	50 lbs/carton	\$240.00

## Performance and Verification Ranking

Verification Ranking: ●●●●

Field tests have proven that the proprietary OARS Smart Sponge filtration media will remove up to 95% of the oil and grease in stormwater runoff in low flow situations. Oil is bonded within the Smart Sponge, which eliminates the possibility of leaching back into the environment.

Studies:

- *Field Test Results of the Ultra-Urban Filter Manufactured by AbTech Industries.* Astro Environmental, LLC. December 1999.

## Installation Contact

No existing New Hampshire installations to date. For contact information of installations outside of New Hampshire and for updates please contact AbTech Industries.

Additional Installations:

Wrentham Premium Outlet Center, Wrentham, MA  
Environmental Disposal Corporation, Bedminster, NJ  
Septic System Management, Belle Mead, NJ

**Manufacturer**

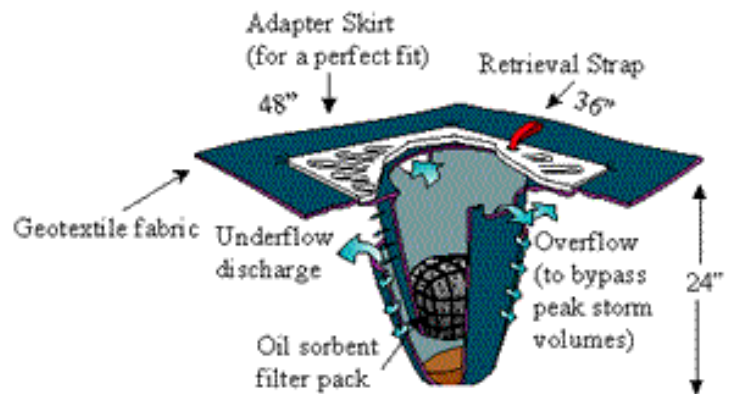
Company: AbTech Industries  
Address: 4110 North Scottsdale Road, Suite 235  
Scottsdale, AZ 85251  
Telephone: (480) 874-4000 or (800) 545-8999  
Fax: (480) 970-1665  
Email: [info@abtechindustries.com](mailto:info@abtechindustries.com)  
Website: [www.abtechindustries.com](http://www.abtechindustries.com)  
Contact: Don Thompson, Marketing Coordinator

### 5.5.2. StreamGuard™ Catch Basin Insert

#### General Description

The StreamGuard™ Catch basin Insert comes in three models: Model 3001 for oil and sediment removal, Model 3002 for trash and debris removal, and Model 3003 for sediment removal. The inserts' universal skirt adapter allows units to be installed in any size catch basin up to 30" x 40". The units are installed under storm drain grates and treat water through filtration, screening, gravity settling, and/or absorption.

When stormwater enters the catch basin, it is directed into the StreamGuard™ insert. The geotextile fabric first acts as a filter, allowing water to pass, but retaining target pollutants. When the fabric can no longer filter due to accumulated contaminants, it begins to operate in its designed long-term mode. In this mode, the body of the insert fills with water, providing detention for the gravity settling of sediment, which is captured in the bottom of the insert.



#### Site Considerations

The StreamGuard™ is designed to remove oil, grease, sediment, trash, and debris from stormwater runoff. Specific potential applications include:

##### Model 3001: StreamGuard™ Insert for Oil and Sediment Removal

- Parking lots
- Construction sites
- Marinas
- Industrial sites
- Vehicle washing facilities

##### Model 3002: StreamGuard™ Insert for Trash and Debris Removal

- Popular waterfront tourist areas
- Stadiums
- Street fairs
- Wood product facilities

##### Model 3003: StreamGuard™ Insert for Sediment Removal

- Construction sites

The StreamGuard™ Catch Basin Insert models are selected depending on target contaminants to specific site conditions. Table 5.11 summarizes the flow rates, overflow rates, and treatment flow rates for the StreamGuard™ system models.

##### Model 3001: StreamGuard™ Insert for Oil and Sediment Removal

- Contains a 1-pound granular polymer element, which can absorb up to two-thirds of a gallon of gasoline, diesel or other hydrocarbon.

**Model 3002: StreamGuard™ Insert for Trash and Debris Removal**

- Uses a screen bag designed to trap cigarette butts, candy wrappers, bottle caps, etc. It has an emergency overflow for high-storm events and may be emptied and reused.

**Model 3003: StreamGuard™ Insert for Sediment Removal**

- The geotextile fabric first acts as a filter, allowing water to pass, but retaining sediments.

Table 5.11. Total flow rate, overflow rate, and treatment flow rate of StreamGuard System models.

	Model 3001	Model 3002	Model 3003
Total flow rate capacity (new condition)	500 gpm	1000 gpm	500 gpm
Emergency overflow rate	250 gpm	250 gpm	250 gpm
Design treatment flow rate	≤ 20 gpm	≤ 40 gpm	≤ 20 gpm

**Installation**

To install the StreamGuard™ insert, remove the catch basin grating, lay the insert skirt over the opening, and replace the grate. Inserts are made of 100% non-woven polypropylene geotextile fabric. They will fit catch basins as small as 12" x 12" (12" diameter), and up to 30" x 40" (30" diameter). StreamGuard™ insert dimensions are 36" w x 48" l x 24" h, and can be installed in minutes. StreamGuard™ inserts are not recommended for curb-style drains or for any drains that consistently receive unusually heavy stormwater flows. No pretreatment is required for the StreamGuard™ system.

**Maintenance**

The manufacturer recommends monthly inspection of each insert installed as a Best Management Practice. Maintenance frequency will vary depending on the amount and type of pollutants present.

**Model 3001:**

- Maintenance may be required at 3- to 6-month intervals where moderate levels of hydrocarbons and sediments are encountered.

**Model 3002:**

- Where moderate levels of trash are encountered, weekly or monthly maintenance may be required. Maintenance consists of removing the unit, emptying the accumulated trash, and replacing the unit in the catch basin. At heavily littered sites, it may be advisable to inspect inserts after each significant storm event.

**Model 3003:**

- In applications where moderate levels of sediment are encountered, weekly or monthly maintenance may be required. Maintenance consists of removing the unit, emptying the accumulated sediment, and replacing the unit in the catch basin. On active construction sites, it may be advisable to inspect the inserts after each significant storm event.

The lifetime of the StreamGuard™ varies between models:

**Model 3001:**

- Replacement frequency for oil and sediment inserts depends on contaminant loading. In many applications with drainage areas equal to or less than 10,000 square feet, the inserts will operate as designed for 6 months or longer. In heavy-loading applications or poorly controlled sites, however, the inserts should be replaced on an as-needed basis.

Models 3002 and 3003:

- Trash and debris inserts and inserts for sediment control are typically replaced annually. However, wear and tear due to direct and frequent contact with vehicle tires will substantially reduce the unit's longevity.

**Aesthetics, Community and Safety**

Concerns regarding aesthetics, community support, and safety are highly site specific. For further information refer to Chapter 2, Decision Criteria.

**Costs**Model 3001 StreamGuard™ Insert for Oil and Sediment Removal

Recommended retail price for 1 unit is \$93.00; 10-pack inserts are \$820.00.

Model 3002 & 3003 StreamGuard™ Insert for Trash and Debris Removal

Recommended retail price for 1 unit is \$64.00; 10-pack inserts are \$560.00.

**Performance and Verification Ranking**

Verification Ranking: ●●●●

Studies:

Model 3001:

- *King County Surface Water Management Division of Washington State demonstrated oil removal efficiencies of 88% when tested in a park-and-ride lot catch basin. Catch basin inserts installed at SeaTac International Airport's passenger pick-up area show average removal efficiencies for Total Suspended Solids of 80%, and for oil & grease of 94%.*

**Installation Contact**

For contact information of StreamGuard™ installations and for updates please contact KriStar Enterprises, Inc. StreamGuard™ has installations in the following locations:

- New Hampshire DOT, Nashua, NH
- Three Oaks Development, Norwood, MA
- Exeter Energy Limited Partnership, Sterling, CT
- Consolidated Edison, New York, NY
- Reichold Chemical Company, Newark, NJ
- Community Bus Lines, Inc., Passaic, NJ
- US Coast Guard, Chesapeake, VA

**Manufacturer**

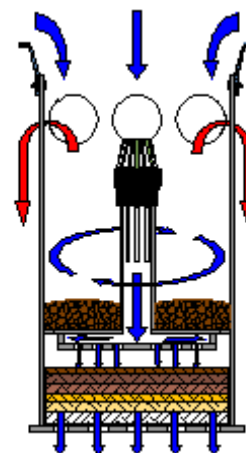
Company: Bowhead Manufacturing Company, LLC.  
 Address: P.O. Box 80327  
 Seattle, WA 98108  
 Telephone: (800) 909-3677  
 Fax: (888) 234-3677  
 Website: [www.bmccatalog.com/streamguard.html](http://www.bmccatalog.com/streamguard.html)  
 Email: [bmc@bowhead.com](mailto:bmc@bowhead.com)

### 5.5.3. Aqua-Guard™ Catchbasin Insert

#### General Description

The AquaGuard™ catch Basin Insert is designed to remove contaminants from stormwater runoff. Each AquaGuard™ insert includes a sediment collection/storage area and a patented cellulose fiber filter media contained in filter bags. The AquaGuard™ is available in various sizes and models and can be custom designed to fit most storm drains.

Flow enters the AquaGuard™ Catch Basin Insert at the sediment collection/storage area from above, capturing sediments, trash and debris. The pre-treated water travels down the center column and spreads across the filter media. The water is then filtered, removing dissolved oil, additional nutrients, and certain metals. Large flows that exceed the filter's capacity are allowed to escape through the overflow holes that are provided at the top of the insert.



#### Site Considerations

The AquaGuard™ is designed to remove coarse sediment, trash, and debris, and pollutants such as dissolved oil, nutrients and metals. As an element of a treatment train approach for stormwater pollution prevention plans, the AquaGuard™ Catch Basin Insert can be custom fit to any standard catch basin. Specific potential applications include:

- Roadways and parking lots
- Highway and transportation facilities
- Watershed protection
- Fast food restaurants

As the filter media reaches its flow capacity, water in the sediment chamber rises to the level of the overflow holes and exits the insert, reducing the possibility of flooding at the site. Table 5.12 summarizes the sediment and debris storage capacity and the amount of oil removal for each model.

Table 5.12. Sediment and debris storage capacity and oil removal for the AquaGuard™ system.

AquaShield Series	Sediment and Debris Storage (feet <sup>3</sup> )	Oil Removal (gallons)
AG-18	0.75	1.50
AG-24	1.4	3.00
AG-36	3.2	6.60
AG-48	6.6	13.80

#### Installation

The AquaGuard™ is fabricated using High-Density Polyethylene (HDPE) and stainless steel. The stainless steel support collar on the AquaGuard™ is custom sized to fit the catch basin frame. Installation involves removing the catch basin grate and lowering the AquaGuard into the catch basin. The flange of the stainless steel support collar will rest in the same lip that receives the catch basin grate.

The AquaGuard™ is available in a range of sizes. Table 5.13 summarizes the dimensions and size specifications of each model. No pretreatment is required for the AquaGuard™.

Table 5.13. AquaGuard dimensions and size specifications by model.

AquaShield Series	Surface Drain Opening Size	Discharge Pipe Dia. (inches)	Filter Body Dia. (inches)	Filter Unit Height (inches)	Filter Pillow Dia. (inches)
AG-18	18 – 24	6 – 12	14	23.5	12
AG-24	24 – 36	12 – 18	20	24.5	18
AG-36	36 – 48	18 – 24	30	28.5	27
AG-48	48 - 54	24 - 36	42	30.5	39

### Maintenance

Inspection is established for each site and maintenance is typically scheduled quarterly or after significant storm events. A routine inspection and maintenance program is established for each unit based on the volume or load of contaminants of concern, the frequency of releases of contaminants and the facility or location, and the nature of the area being drained. The maintenance routine includes the vacuuming of accumulated sediment and debris followed by inspection, replacement, or both of the filter media.

### Aesthetics, Community and Target Contaminants

Concerns regarding aesthetics, community support, and safety are highly site specific. For further information refer to Chapter 2, Decision Criteria.

### Cost

The AquaGuard system ranges in price from \$1500 to \$3500 per unit.

### Performance and Verification Ranking

Verification Ranking: **0**

To date AquaShield, Inc. for updates in performance studies.

### Installation Contact

No existing New Hampshire installations to date. For contact information of installations outside of New Hampshire and for updates please contact AquaShield, Inc.

### Manufacturer

Company: AquaShield, Inc  
 Address: 2733 Kanasita Drive, Suite A  
 Hixson, TN 37343  
 Telephone: (423) 870-8888 or (888) 344-9044  
 Fax: (423) 870-1055  
 Website: [www.aquasheildinc.com](http://www.aquasheildinc.com)  
 NE Contact: Gregg Novick  
 Email: [aquanovick@worldnet.att.net](mailto:aquanovick@worldnet.att.net)

## 5.5.4. DrainPac™

### General Description

The DrainPac™ is a storm drain catchment and filtration liner. It is available in four sizes, all equipped with a choice of two overflow systems, the hydraulic bypass and the uninhibited bypass. The DrainPac™ insert is made from a high-density polymeric support structure and is available in 3.0 oz., 8.0 oz, 12.0 oz, and 16.0 oz. non-woven or woven mesh. The base section of the insert is overlapped and welded for additional strength. The insert and filter media are supported by a custom-fit, metal mounting support frame made of stainless steel with a minimum thickness of 1/8”.

Each drain is outfitted with overflow protection, consisting of a bypass system that allows flow to be bypassed in heavy flow situations. Drain filters are available without overflow protection, and curb inlets are not equipped with overflow bypass.

### Site Considerations

The DrainPac™ insert is designed to filter pollutants, debris, and solids prior to discharge into storm drain systems. Specific potential applications include:

- Streets, commercial parking lots and shopping centers
- Construction erosion sites
- Outfalls
- Maintenance/ fueling facilities and automobile service stations

DrainPac™ personnel are available to work with clients to examine current stormwater designs in order to locate areas where DrainPac™ will be the most effective and have the greatest impact. Important factors to evaluate are the influent stormwater contents, the areas that drain to the selected catch basin, and whether there are specific flow rates. This evaluation is for the purpose of selecting the right the correct filter inlet media to install out of the six available. Tables 5.14 and 5.15 summarize the DrainPac™ filter liner and support structure specifications.

Table 5.14. DrainPac filter liner specifications.

Property (oz./sq.ft)	Water Flow Rate (gpm/sq.ft)	Thickness (ml)	Mullen Burst Strength (psi)	Micron Rating
3.5	140	50	200	400
8.0	110	85	360	220
12.0	90	120	640	125
16.0	50	150	750	95
Screen mesh 10.0 oz./sq.yd	N/A	30	360	11/11 ends/in. construction

Table 5.15. DrainPac support structure specifications.

Property	Value
Thickness (inches)	0.23
Strength Wall (lb/ft)	7,540
Strength Bottom (lb/ft)	15,080

## Installation

The DrainPac™ is available in four styles: Grate Top, Curb, and round configurations, as well as styles designed for outfall, or “end-of-the-pipe” applications, and drop-in drain applications. Each drain filter system includes all necessary hardware for complete installation and adequate spare hardware to accommodate each replacement bag filter. Installation includes, removing the drain cover, anchoring the flatbar and support basket following detailed manufacturer instructions, and inserting the filter bag, before replacing the drain cover. No pretreatment is required for the DrainPac™ system.

## Maintenance

A proper maintenance program is critical to ensuring that the flow through storm drain filter is uninhibited. The manufacturer recommends that all inspections take place prior to installation to determine areas of effectiveness. After installation, inspections are needed in order to establish maintenance schedules.

## Aesthetics, Community and Safety

Concerns regarding aesthetics, community support, and safety are highly site specific. For further information refer to Chapter 2, Decision Criteria.

## Cost

Because DrainPac™ typically designs for retrofit installations, they do not have pre-priced standard model options. Prices are normally quoted on an individual basis. Prices are determined using a formula incorporating the cubic feet of the catch basin. Contact manufacturer for additional cost details and quotes.

## Performance and Verification Ranking

Verification Ranking: **0**

Please contact PacTec, Inc. for updated performance information.

## Installation Contact

No existing New Hampshire installations to date. For contact information of installations outside of New Hampshire and for updates please contact PacTec, Inc.

DrainPac has been implemented in the following states:

Alabama	Georgia	Mississippi	Texas
Arkansas	Louisiana	Missouri	Washington
California	Michigan	North Carolina	
Florida	Massachusetts	Tennessee	

## Manufacturer

Company: PacTec, Incorporated  
 Telephone: (800) 272-2832 or (225) 683-8602  
 Fax: (225) 683-8711  
 Website: [www.drainpac.com](http://www.drainpac.com)  
 Email: [drainpacinfo@drainpac.com](mailto:drainpacinfo@drainpac.com)

### 5.5.5. Fossil Filter™

#### General Description

The Fossil Filter is a catch basin filtration system that uses a filter media to remove target contaminants from inlet runoff flows before draining into surface waters. It is adaptable to both new and retrofit construction. The Fossil Filter treats the first flush of stormwater runoff from a rain event and provides an overflow capability sufficient to prevent the system from being clogged. The sorbent filter media is a non-leaching inert blend of mineral that contains non-hazardous ingredients.



#### Site Considerations

The Fossil Filter removes and contains sediment, debris, trash, and petroleum hydrocarbons (oil and grease from fossil fuels) from stormwater runoff. In addition, some heavy metals attached to sediments are removed. Specific potential applications include:

- Areas subject to silt, debris, and hydrocarbons
- Parking lots, public streets
- Aircraft ramps
- Vehicle storage areas

The Fossil Filter™ can be used in a variety of project sites depending upon drainage area, contaminant loading, and other site conditions. Table 5.16 summarizes the Fossil Filter™ products and their recommended uses.

Table 5.16. Fossil Filter product descriptions and recommended uses.

Product Name	Product Description	Recommended Use
Flo-Guard Insert	Made of replaceable geotextile fabric. Collects silt, debris, petroleum hydrocarbons. Filtering device at low flow. High flow bypass	Areas subject to silt, debris, hydrocarbons. Parking lots, aircraft, ramps, vehicle storage areas, public streets
Flo-Guard High Capacity Catch Basin Insert	For new or retrofit construction. Square, rectangular, round. Collects and contains sediment, debris, hydrocarbons. High flow bypass.	Areas with higher than normal sediment & debris, and mod. high levels of hydrocarbons. Streets, equip. storage, maintenance yards
Perk Filter Insert	Converts catch basins into detention basins. Collects solids, silt & debris. Creates sump (detention) area above inlet and outlet pipes. Filters oil & grease. High flow bypass.	Areas with high silt, sediment & debris and moderately high levels of hydrocarbons.
Hydrocarbon Filter Insert	“Hard body” inserts to collect and contain hydrocarbons. Made of fiberglass, plastic, and stainless steel materials.	Areas with little or no silt or debris and higher levels of hydrocarbons. Parking lots, fueling areas.
Fossil Filter FB-2 Catch Basin	Complete drainage structure: fiberglass catch basin, hydrocarbon filter & grate. For areas where burial depth on the storm drainpipe does not allow for the installation of a standard filter insert. With or without a sump.	Well suited for gas stations, parking structures, or other areas where shallow piping is necessary.

## Installation

Installation of the filtration device does not require extensive modification of the catch basin. Installation contractors are licensed and insured in accordance with agency requirements. Filtration devices installed into grated or combination grate with curb opening inlets are self-supporting and installed without the use of anchoring devices.

Devices for curb inlets (no grate) have a removable filter basket that can be removed for maintenance without physically entering the drainage inlet. The device is secured into the inlet wall, across and beneath the curb opening, using corrosion resistant anchors. All anchoring devices are installed within the interior of the drainage inlet to avoid foot or vehicle traffic.

Filtration devices are installed in such a manner as to direct all flows into the device. Distance (gaps) between the inlet wall and device should not be more than one inch. Gaps of less than one inch should be sealed with a flexible weatherproof sealant.

No pretreatment is required for use of the Fossil Filter™

## Maintenance

The installed Fossil Filter requires periodic inspection and removal of all foreign objects (leaves, grass, paper, etc.). The area around the inlet should be swept on a regular basis. The installed Fossil Rock adsorbent should be inspected and replaced if the surface of the granules is more than 50% coated with contaminants or if the unit has become clogged with sediment. To ensure efficiency, it is recommended that, at a minimum, the units be inspected at least three times per year. In areas subject to excessive debris, the inspections should be more frequent.

Maintenance Plans are available through KriStar Fossil Filter. The Maintenance Plans are based on the filter's exposure to silt, sediment, debris, and petroleum hydrocarbon contaminants. The basic plan includes three inspections per year, per filter, and, based on exposure, up to three cleanings and up to three changes in filter medium. Custom plans can be developed for sites with higher contaminant loading. Each plan provides for proper handling and disposal of exposed adsorbent.

The maintenance cost is based on the number of inspections, cleanings and filter medium changes, the number of filters installed at the site, etc. An average cost for a typical three-visit maintenance plan is approximately \$200 per year or under \$70 per visit.

## Aesthetics, Community and Safety

Concerns regarding aesthetics, community support, and safety are highly site specific. For further information refer to Chapter 2, Decision Criteria.

## Cost

The Fossil Filter catch basin system costs approximately \$500.00 per unit depending upon the size of the existing basin. Replacement kits of Fossil Rock Filter medium for a 24" x 24" filter insert are approximately \$40.00.

## Performance and Verification Ranking

Verification Ranking: ●●●●

Testing of the Fossil Filter was conducted by the Sandine Engineering Associates of Santa Rosa, and the Eagle Engineering of Sacramento, California. Both showed that installed Fossil Filters did not impede maximum design flow of the inlet, and that the installed filter medium would effectively perform its filtering function with flows in excess of 12 gallons per minute per linear foot of filter surface. Field-testing on new Fossil Filters continues on a regular basis and has shown removal efficiencies of 85% for petroleum hydrocarbons and 90% for sediment of 400 microns or greater.

Studies:

- *Hydraulic Testing of Fossil Filter™*. Sandine Engineering. May 1995.
- *Laboratory Testing of Fossil Rock Adsorbent™*. Prism Laboratories. November 1995.

## Installation Contact

No existing New Hampshire installations to date. For contact information of installations outside of New Hampshire and for updates please contact KriStar Enterprises, Inc.

## Manufacturer

Company: KriStar Enterprises, Inc.  
Address: P.O. Box 7352  
Santa Rosa, CA 95407-0352  
Telephone: (800) 579-8819  
Fax: (707) 524-8186  
Email: [customercare@kristar.com](mailto:customercare@kristar.com)  
Website: [www.kristar.com](http://www.kristar.com)

### 5.5.6. Grate Inlet Skimmer Box

#### General Description

The Grate Inlet Skimmer Box is designed to pass incoming stormwater through the skimmer tray and come in contact with the hydrocarbon boom. The multi-stage filtration process captures pollutants, from hydrocarbons, grains of sand, grass clippings, and human trash. The deflection shield keeps the majority of the water turbulence adjacent to the filters, which prevents the escape of fine particles. The skimmer tray traps floatables and prevents them from floating through the overflow holes. If the stormwater flow exceeds the flow capacity of the lower and upper filters, water is allowed to exit through the overflow bi-pass. After the storm event has passed, the Grate Inlet Skimmer Box drains of all water and dries.

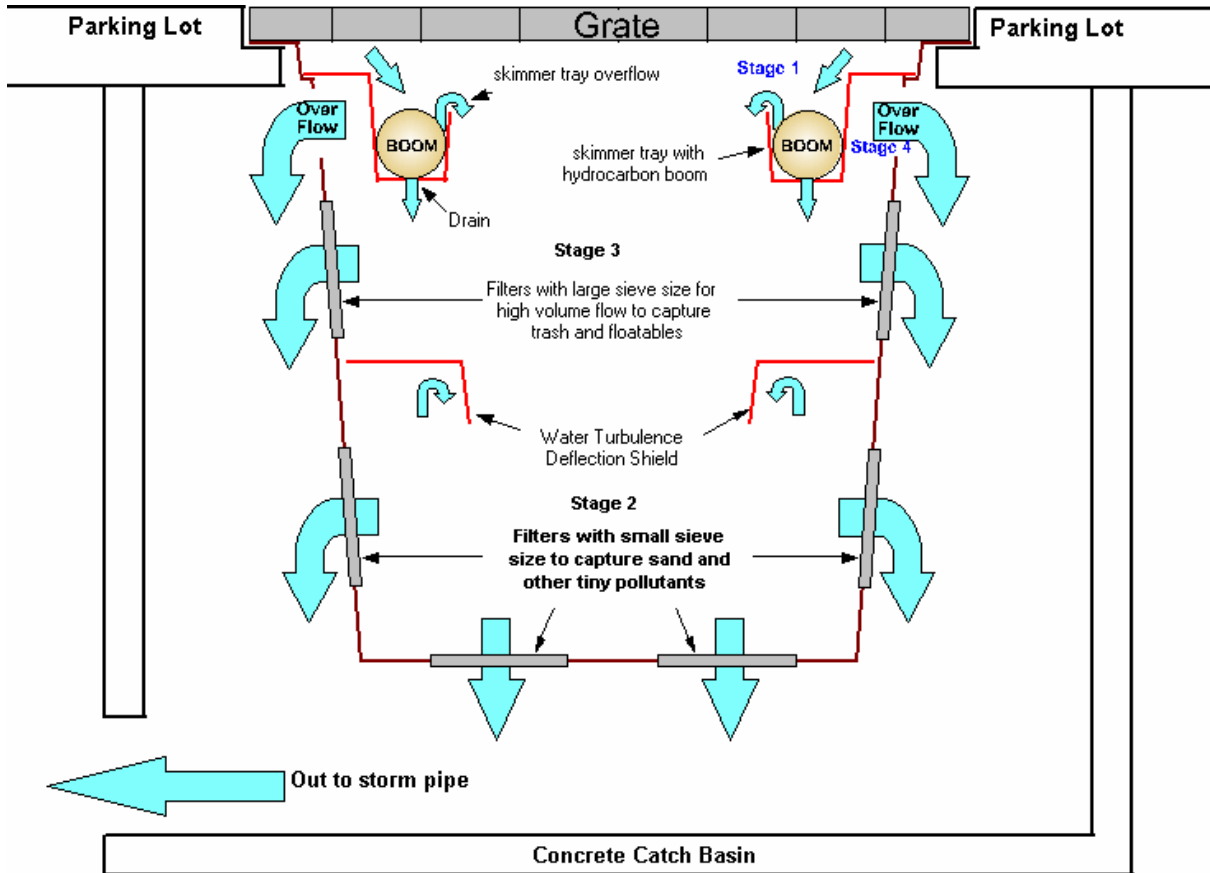


Figure 5.3. Suntree Technologies, Inc's Grate Inlet Skimmer Box schematic.

#### Site Considerations

The Grate Inlet Skimmer Box is designed to capture sediment, debris, trash, and hydrocarbons from stormwater runoff. Specific potential applications include:

- Public streets
- Parking lots
- Vehicle storage areas

The Grate Inlet Skimmer Box can be custom designed and shaped for retrofits. The design is dependent upon site conditions.

## Installation

Installation of the Grate Inlet Skimmer Box includes removing the grate, inserting the Skimmer Box, and replacing the grate. Professional installation is included with the purchase of the unit. Pretreatment is not required for use of the Grate Inlet Skimmer Box. Standard units come in the following sizes:

- 24" x 24"
- 25" x 25" up to 28" x 36"
- 29" x 37" up to 36" x 48"
- 37" x 49" up to 48" x 54"
- Larger sizes can be accommodated.

## Maintenance

Correct maintenance of any BMP is the only way to ensure efficiency and effectiveness. The Grate Inlet Skimmer Box must be routinely inspected and maintained to function properly.

The skimmer tray and deflection shield are a single unit, which can be removed for cleaning. Once the unit is removed, turn the filter box over and empty into a disposal container. Depending on the contaminant level at a given site, the hydrocarbon boom may need replacement. Maintenance Plan services are available for professional maintenance activities including, disposal of debris and replacement of the hydrocarbon boom.

## Aesthetics, Community and Safety

Concerns regarding aesthetics, community support, and safety are highly site specific. For further information refer to Chapter 2, Decision Criteria.

## Costs

Table 5.17 summarizes pricing of the Grate Inlet Skimmer Box. Please contact manufacturer for updates on current prices.

Table 5.17. Suntree Technologies, Inc's Grate Inlet Skimmer Box price list.

Flange Dimensions	Price Per Unit
Up to 24" x 24"	\$695.00
25" x 25" up to 28" x 36"	\$795.00
29" x 37" up to 36" x 48"	\$895.00
37" x 49" up to 48" x 54"	\$995.00
For larger sizes – call for quote	

## Performance and Verification Ranking

Verification Ranking: 

Efficiency testing has been conducted by Suntree Technologies, Inc. The maximum removal was 74% for suspended solids.

Studies:

- *Site Evaluation of Suntree Technologies, Inc. Grate Inlet Skimmer Boxes for Debris, Sediment, and Oil & Grease Removal.* Reedy Creek Improvement District Planning & Engineering Department, Environmental Services Laboratory. January 2000.

### Installation Contact

No existing New Hampshire locations to date. For contact information of installations outside of New Hampshire and for updates please contact KriStar Enterprises, Inc.

### Manufacturer

Company: Suntree Technologies, Inc.  
Address: 720 Mullet Road, Suite H  
Cape Canaveral, FL 32920  
Telephone: (321) 799-0001  
Fax: (321) 799-1245  
Website: [www.suntreetech.com](http://www.suntreetech.com)

### 5.5.7. Hydro-Kleen

#### General Description

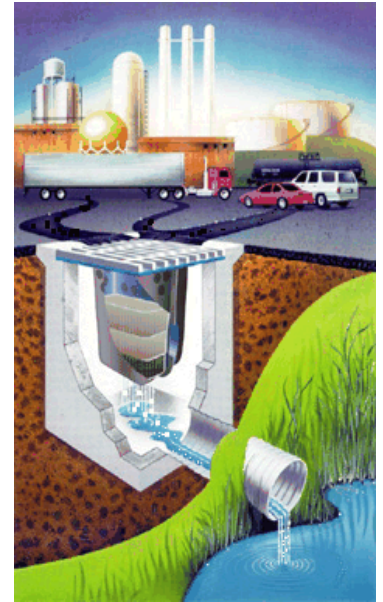
The Hydro-Kleen is a sedimentation and contamination filtration system that can be inserted into existing or new catch basin systems. Hydro-Kleen can work with internal or external sedimentation chambers and/or with other BMPs.

When water enters the unit, it is directed into a sedimentation chamber that collects coarse sediments and debris. The stormwater then passes through a series of filters for treatment of hydrocarbons and organically bound metals.

#### Site Considerations

The Hydro-Kleen filtration system is designed to remove hydrocarbons, organically bound metals, PCBs, pesticides, VOCs, sulfides and other runoff contaminants from stormwater and industrial runoff. Specific potential applications include:

- Public streets
- Parking lots
- Vehicle service areas
- Industrial facility areas



Hydro-Kleen units are designed to treat the “first flush” and provide overflow bypass to prevent backup and flooding.

#### Installation

Installation of the Hydro-Kleen consists of clearing the work area, removing the existing grate, and confirming the grate dimensions with the filter and insert dimensions. The filtration unit is placed into the catch basin and the metal frame is caulked to prevent water bypass. The filter media is installed in the filter housing and the grate is replaced. The Hydro-Kleen system does not require pretreatment. It can, however, be used as a pretreatment device in conjunction with other BMP systems.

#### Maintenance

The unit must be maintained regularly in order to prevent saturation of filter media by contaminants and system clogging due to sedimentation and debris accumulation. It is recommended by the manufacturer that maintenance be conducted every 4 to 6 months. Inspection should be done regularly to determine if more or less frequent maintenance is needed depending on specific site characteristics.

Maintenance of the unit is accomplished by removing the cover, vacuuming the chamber with an 8" or smaller hose, and replacing the media filters. Maintenance takes only minutes and does not require professional training.

#### Aesthetics, Community and Safety

Concerns regarding aesthetics, community support, and safety are highly site specific. For further information refer to Chapter 2. Decision Criteria.

## Costs

The cost of the Hydro-Kleen system averages approximately \$2,000.00 per unit. Filter media replacements cost approximately \$400.00 including labor for change out.

## Performance and Verification Ranking

Verification Ranking: ●●●

Certified laboratory tests were conducted on the Hydro-Kleen filter media. The results show that hydrocarbons and other contaminants were reduced to non-detectable levels.

Studies:

- *Third Party Testing Results for the Hydro-Kleen System.* Greg S. Conrad, Ph.D.

## Installation Contact

No existing New Hampshire installations to date.

Location: Various installations  
 Contact: Dennis Ozsust  
 Inland Waters Pollution Control  
 2021 S. Schaefer Hwy.  
 Detroit, MI 48217  
 (313) 841-5807 extension 222

## Manufacturer

Company: Hydro Compliance Management, Inc.  
 Address: 8741 Main St. Suite J  
 Whitmore Lake, MI 48189  
 Telephone: (800) 526-9629 or (734)449-8860  
 Fax: (734) 449-9274  
 Email: [hcm@hydrocompliance.com](mailto:hcm@hydrocompliance.com)  
 Website: [www.hydrocompliance.com](http://www.hydrocompliance.com)

### 5.5.8. The Inceptor

#### General Description

The Inceptor suspends from any existing storm grate or curb inlet. The Inceptor frame is made from #304 stainless steel, and hangs from a two-point suspension system that creates a tipping effect during high flows. This design is to prevent stormwater backup and flooding. The patented PolyDak filter pillow slides inside the frame and will not leach or impact the water flow rate.



#### Site Considerations

The Inceptor is designed to capture oils, grease, PCBs, heavy metals attached to sediments, and debris. Specific potential applications include:

- Public streets
- Parking areas
- Vehicle service areas

The Inceptor comes in two standard dimensions 2' x 2' and 2' x 4', and can be custom manufactured to fit any dimension basin. The patented PolyDak filter pillow is made of melt spun thermoplastic synthetic material. The number of Inceptor units installed is dependent upon specific site conditions.

#### Installation

The installation process takes approximately five minutes per unit. Once the catch basin grate is removed, the suspension hardware is attached to the grate and the Inceptor is attached to the suspension hardware. The patented PolyDak filter pillow gets placed into the filter frame, and the grate is replaced. No pretreatment is required for the Inceptor.

#### Maintenance

Under normal conditions, the filter pillow needs annual replacement. Under extreme conditions, the filter pillow may require replacement twice per year. Inspection is recommended to determine the correct maintenance schedule for filter pillow replacement. The PolyDak filter pillow must be replaced annually. The Inceptor unit will last the lifetime of the catch basin.

#### Aesthetics, Community and Safety

Concerns regarding aesthetics, community support, and safety are highly site specific. For further information refer to Chapter 2, Decision Criteria.

#### Cost

Product costs include the stainless steel cage and the PolyDak filter pillow.

2' x 2'                \$625.00

2' x 4'                \$1100.00

Average annual cost after initial purchase:

2' x 2'                \$69.00

2' x 4'                \$89.00

## Performance and Verification Ranking

Verification Ranking: ●●●●

The Inceptor's patented PolyDak filter medium has been field tested by the Atlantic Coast Laboratories.

Studies:

- *Burlington County Soil and Conservation District Six Month Field Analysis.* Atlantic Coast Laboratories, Inc. December 2000.
- *Salvage Yard Six Month Field Analysis.* Atlantic Coast Laboratories, Inc. May 2001.
- *Mount Holly, New Jersey Six Month Field Analysis.* Mount Holly Municipal Utilities Authority. July 2001.

## Installation Contact

No existing New Hampshire installations to date.

Location: Mount Holly, NJ  
Date Installed: April 2001  
Contact: Teresa Rogan  
Municipal Utilities Authority  
Mount Holly, NJ 08060  
(609) 267-0015  
rogan@mhmuia.com

## Manufacturer

Company: Stormdrain Solutions, an RDI Company  
Address: 333 Beaumont Road  
Devon, PA 19333  
Telephone: (877) OUR-PIPE  
(877) 687-7473  
Fax: (610) 687-6327  
Website: www.stormdrains.com

## 5.6. High Efficiency Sweepers

### 5.6.1. Schwarze Sweeper

#### General Description

The Schwarze Sweeper EV-Series machines use no water during the sweeping process. Although capable of sweeping in wet conditions, the small-micron pickup capability is due to their dry pickup process. Instead of suppressing dust by using water sprays, EV-series sweepers utilize a patented dry airflow and pickup system. The patented debris-collection head on Schwarze EV-series machines combines dual counter-rotating brooms with approximately 15,000 cubic feet per meter of air movement. The cleaning system removes dust and debris from the pores of concrete, while still picking up large debris.



The EV-Series sweepers come in two models, the EV1 and a smaller version EV2. Both models have contour-following, opposed-rotating transverse brooms, enclosed in a vacuum head. These are fed by outrigger curb brooms, mounted ahead of the vehicle body, which remove debris from the surface and entrain it in the air stream. A fan pulls ambient air from the surface through a head and into the containment section where it is pulverized and compacted. The air is pulled through 2.5-micron media filters. The cabs of both models are equipped with closed circuit TV monitors to allow a constant view to the rear of the sweeper. In addition, the cabs are pressurized to offer continuously filtered air to the operator.

- EV1: Rear Steering unit  
108" cleaning path  
7.2 million ft<sup>3</sup> of air filtered in an 8-hour period
- EV2: Four-wheel steering unit  
80" cleaning path  
5.6 million ft<sup>3</sup> of air filtered in an 8-hour period  
Able to be used inside buildings, parking garages, and other structures

In addition to the EV-Series sweepers, Schwarze Industries, Inc. offers the A-Series of regenerative air sweepers, which can also be used to remove fine particles.

#### Site Considerations

The EV-Series sweepers are designed to pick up particles as small as 2.5 micron to reduce potential particle content in stormwater runoff. They have been designed for various types of pavement cleaning including:

- Work in oil refineries
- Construction sites
- Landfills
- Public roadways & Parking areas

## Installation

No pretreatment is necessary for the Schwarze Sweeper EV-Series, however, the sweepers may be used as a stormwater pretreatment in conjunction with other BMPs.

## Maintenance

As with any piece of power equipment, it is recommended by the manufacturer that a regularly scheduled maintenance plan be followed for the Schwarze Sweeper. It is suggested that a qualified mechanic be used to maintain and service sweepers. Schwarze Industries' supplies recommended maintenance schedules for their equipment.

## Costs

The average cost of the EV1 sweeper is \$225,000 and the EV2 sweeper is \$185,000.

## Performance and Verification Ranking

Verification Ranking: 

Independent testing has shown that the dry cleaning approach allows EV-series machines to collect and contain 99.6% of small micron particulates. The EV-series sweepers have the capacity to filter up to 1 million cubic feet of air per hour to 2.5 microns. Currently testing is being carried out or planned through collaboration with a variety of government agencies.

Studies:

- *Effectiveness of Envirowhirl Technology*. Roger Bannerman, Wisconsin Department of Natural Resources.
- *Filtration Capability Test Report*. Russell Fondaw, Industrial Testing Laboratories, Inc. 1994.
- *Street Sweeper Pick-up Performance*. Roger Sutherland, Pacific Water Resources.

## Contact

No existing New Hampshire installations to date. For contact information of Schwarze Sweepers outside of New Hampshire and for updates please contact Schwarze Industries, Inc.

## Manufacturer

Company: Schwarze Industries, Inc.  
 Address: 1055 Jordan Rd.  
 Huntsville, AL 35811  
 Telephone: (800) 879-7933  
 Fax: (256) 851-1105  
 Email: support@schwarze.com  
 Website: www.schwarze.com

### 5.6.1. TYMCO® Regenerative Air Sweeper

#### General Description

The TYMCO Regenerative Air Sweeper uses a controlled blast of air to dislodge debris from the surface path. All debris picked up by the pick-up head is directed up the 14-inch diameter suction hose and into the hopper. The pick-up head is 87 inches wide and can be extended to 133 inches. Because of the regenerative air system, clean air is returned to the blower to start the process again, reducing the amount of air exhausted back into the environment and the amount of particle resettling.



#### Site Considerations

TYMCO sweepers remove trash, dirt and fine particulates. They are designed for use without water, however, they are able to operate in rainy or wet conditions and can adjust to road curvatures and irregularities. They have been designed for various types of pavement cleaning including:

- Parking areas
- Roadways
- Construction sites

Tymco Sweepers are also able to clean the following if equipped with the auxiliary hand hose:

- Catch basins
- Around landscaping & fence lines

#### Installation

No pretreatment is necessary for the TYMCO sweeper; however, the sweeper may be used as a stormwater pretreatment in conjunction with other stormwater BMPs.

#### Maintenance

As with any piece of power equipment, it is recommended by the manufacturer that a regularly scheduled maintenance plan be followed for the TYMCO sweeper. It is suggested that a qualified mechanic be used to maintain and service the sweepers. TYMCO provides Operator Training and Safety videos as well as Operator and Mechanic Service Training Schools at no tuition cost at the TYMCO headquarters in Waco, TX.

#### Cost

The average costs of the TYMCO Sweeper models can be seen below in Table 5.18.

Table 5.18. Average cost of TYMCO sweepers by model.

Model	Storage Capacity (cubic yards)	Average Price
600	6	\$125,000
435	4	\$85,000
210	2	\$60,000
Dustless 600	6	\$175,000

## Performance and Verification Ranking

Verification Ranking: ●●●●

The following testing and review has been conducted on the effectiveness of the TYMCO Sweepers:  
Studies:

- *Road Surface Silt Loading Test Results*: TYMCO Model 600 Dustless System Sweeper. Val Cassaday, Ortech. 16 February 1998.
- *Measurement of Street Sweeper Collection and PM10 Generation Final Report*. CE-CERT (College of Engineering-Center for Environmental Research and Technology). Riverside, CA.
- *Certification Request Review*. Alene Taber, South Coast Air Quality Management District. Diamond Bar, CA. 14 September 1999.

## Contact

For contact information of TYMCO Sweepers for updates please contact TYMCO. The following is a list of TYMCO sweeper locations:

Manchester, NH Airport	Town of Somersworth, NH	Town of Gilford, NH
Manchester, NH REDI-MIX	Pease Airport, NH	MassPort, Boston, MA
City of Haverhill, MA	Town of Nahant, MA	USAF, worldwide

## Manufacturer

Company:	TYMCO Regenerative Air Sweepers	
Mail Address:	PO Box 2368 Waco, TX 76703-2368	Street Address: 225 Industrial East Waco, TX 76705
Telephone:	(800) 258-9626	
Website:	www.tymco.com	
Contact:	Bobby Johnson	
NH Contact:	Rick Schults, Sales Representative Casey Equipment & Rental Corp.	
Mail Address:	PO Box 309 Kingston, NH 03848	Street Address: 351 Route 125 Brentwood, NH 03833
Telephone:	(603) 679-9977	
Fax:	(603) 679-1914	



## Glossary of Terms

**AESTHETICS:** Pleasing in appearance or effect. A subjective determination based on an individual's preference.

**BEDROCK:** The solid rock underlying unconsolidated surface material (as soil). NH bedrock types include granitic and metamorphic rock.

**BENTHIC:** Of, relating to, or occurring at the bottom of a body of water. Typically refers to the sediment layers at the bottom of a waterbody.

**BEST MANAGEMENT PRACTICES (BMPs):** For purposes of stormwater management, structural, nonstructural, and managerial techniques that are recognized to be the most effective and practical means to prevent or reduce nonpoint source pollutants from entering receiving waters.

**BIOACCUMULATION:** The retention and concentration of a substance by an organism.

**CATCH BASIN:** A conventional structure for the capture of stormwater in streets and parking areas. It typically includes an inlet, sump, and outlet and provides minimal removal of suspended solids. In most cases a hood also is included to separate oil and grease from the stormwater.

**CFS (CUBIC FEET PER SECOND):** The unit of measure for discharge determining how many cubic feet of a liquid travel a given distance in one second.

**CLARITY:** The measure of the distance one can see into the water or transparency of a body of water. A secchi disk is used to measure clarity.

**CONTAMINANTS:** Substances that become entrained in stormwater and degrade water quality. Sources include process waste, raw materials, toxic pollutants, hazardous substances, or oil and grease.

**DISCHARGE:** Water or effluent released to a receiving waterbody.

**DRAINAGE AREA:** Land area from which water flows into a stream or lake (see also watershed).

**EROSION:** Weathering of soil by running water, wind, or ice.

**EUTROPHICATION:** The natural aging process of freshwater bodies characterized by nutrient enrichment (typically phosphorus and nitrogen), increased plant and algal growth, and decreased dissolved oxygen concentrations.

**FIRST FLUSH:** The precipitation at the beginning of a storm event carrying pollutants, including suspended sediments, at concentrations typically higher than at the middle or end of a storm.

**FLOATABLES:** Materials in stormwater or sanitary flows that float to the surface.

**GPM (GALLONS PER MINUTE):** The unit of measure for discharge determining how many gallons of a liquid travel a given distance in one minute.

**HEAVY METALS:** Any element with an atomic weight of greater than twenty (20), such as copper, cadmium, lead, selenium, arsenic, mercury, and chromium. Heavy metals are typically found in minimal quantities in stormwater, but can be toxic at trace amounts.

**IMPERVIOUS:** The property of a material that does not allow the infiltration of water into and through the pores of the soil, such as pavement or rooftops.

**INFILTRATION:** The gradual movement of water (from precipitation, irrigation, or runoff) into the soil.

**NONPOINT SOURCE (NPS) POLLUTION:** Pollution of surface or groundwater supplies originating from land use activities and/or the atmosphere, having no well-defined point of entry.

**OIL AND GREASE:** This includes hydrocarbons, fatty acids, soaps, fats, waxes, and oils.

**POLLUTANT:** Anything introduced into the environment (soil, water, or air) that degrades the usefulness of a resource.

**PERVIOUS SURFACE:** A porous surface, which allows for the infiltration of water. This typically implies unaltered, natural surfaces without pavement or development.

**PRECIPITATION:** Water that falls to the earth in the form of rain, snow, hail, or sleet.

**PRETREATMENT:** Techniques employed in stormwater BMPs to provide removal (storage, filtration, etc.) and help trap coarse materials before they enter the system.

**RETROFIT:** The installation of a new BMP or improvement of an existing BMP in an already developed area.

**RUNOFF:** Precipitation, snowmelt, or irrigation that flows over the land, eventually making its way to a surface water (such as a stream, river, pond).

**SECCHI DISK:** 20-cm diameter disk with alternating black and white quadrants used to measure water clarity.

**SEDIMENT:** Eroded soil and rock material and plant debris, transported and deposited by runoff.

**SITE PLANNING:** In terms of stormwater management, a preliminary component of a development plan, where the appropriate BMP structures are properly selected and installed.

**STORM DRAIN:** An inlet for the capture of stormwater.

**STORMWATER:** Runoff from a storm event, snowmelt runoff, and surface runoff and drainage.

**TARGET POLLUTANTS/CONTAMINANTS:** The pollutants or contaminants at a specific site, that will be removed upon implementation of a BMP.

**TOTAL SUSPENDED SOLIDS (TSS):** Matter suspended in water or stormwater.

**TURBIDITY:** Reduced clarity in a body of water caused by suspended matter such as clay, silt, algae, and other material, which cause light to be scattered and absorbed, not transmitted in straight lines through the water.

**ULTRA-URBAN:** Densely developed urban areas in which little pervious surface exists.

**VACTORING:** The act of using a vacuum to remove accumulated sediment and other contaminants from containment areas of stormwater treatment devices.

**WATERSHED:** A geographic area in which all water drains into a given stream, lake, wetland, estuary, or ocean.

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